Eight Aporrhaid Gastropod Species from the Cretaceous of the Pacific Slope of North America and Clarification of the Type Species of *Perissoptera*

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ABSTRACT

Eight aporrhaid species from Pacific Slope deposits of late Early Cretaceous through early Late Cretaceous age are assigned among three genera, *Aporrhais*, *Latiala*, and *Alarimella* n. gen. Except for two species of *Latiala*, *Latiala* sp. of Albian age from Oregon and *Latiala heliaca* n. sp. of Cenomanian age from Fresno and Shasta counties, California, the species are of Turonian age. Pacific Slope *Latiala* was most species-diverse during the Turonian and has not been found in younger Pacific Slope deposits. The three Turonian *Latiala* are *Latiala californica* (Gabb) from Siskiyou and Shasta counties, California, *Latiala sigma* n. sp. from the Redding area, Shasta County, and "*Alaria*" *nodosa* Packard, 1922, from the the Redding area, Shasta County, and the Santa Ana Mountains, Orange County, California. *Aporrhais drachuki* n. sp. is from the Santa Ana Mountains, as are two species included in *Alarimella* n. gen., *Alarimella anae* n. sp. and the reassigned species, *Alarimella veta* (Packard, 1922). *Alarimella* resembles *Rimella* of the Strombidae, but possesses an expanded outer lip. The total number of Turonian aporrhaids known from the Santa Ana Mountains, southern California is increased to six species and includes the first record of *Aporrhais* on the Pacific Coast of North America. Selection of a type species for *Perissoptera* from among Cretaceous species listed by Tate, 1865 ensures that *Arrhoges* is not supplanted by *Perissoptera*.

Key words: Aporrhaidae, *Aporrhais*, *Perissoptera*, *Latiala*, *Alarimella*, Cretaceous, Turonian, California.

INTRODUCTION

This paper adds two new species to the four species of Aporrhaidae previously recorded from beds of Turonian age in the Santa Ana Mountains, Orange County, California. *Anchura (Helicaulax?) tricosa* Saul and Popenoe, 1993; *Pyktes diaphron* Popenoe, 1983; *Alaria nodosa* Packard, 1922 which was considered to be a synonym of *Arrhoges (Latiala) californicus* (Gabb, 1864) by Popenoe, 1983; and *Aporrhais vetus* Packard, 1922, which is, herein, assigned to the new genus *Alarimella*, are the previously described species. The new species are *Aporrhais drachuki* and *Alarimella anae*. Recognition of these species in the Turonian of the Santa Ana Mountains increases the known diversity of aporrhaids in those faunas and enlarges the paleogeographic distribution of *Aporrhais* to include the West Coast of North America during the Turonian.

Re-examination of "*Alaria*" *nodosa* and *Latiala californica* indicates that the larger, thicker shelled "*Alaria*" *nodosa* has fewer axial ribs on the spire and should not be included in *L. californica*. *Latiala californica* is not recognized from the Santa Ana Mountains but is present in the Siskiyou Mountains of Oregon and California and in the Redding area, Shasta County, California. *Latiala nodosa* (Packard, 1922) is a common to abundant fossil in the Turonian of the Santa Ana Mountains and also is present in beds of similar age in the Redding area, Shasta County, California. The third *Latiala* species, *L. sigma* n. sp. is described from the Turonian of the Redding area, Shasta County. A fourth species, *L. heliaca* n. sp., is based upon specimens of Cenomanian age from Sunflower Valley, Fresno County, and specimens formerly identified as *Arrhoges californicus* from the Ono area, Shasta County, California. A fifth species of *Latiala* is recognized from specimens of Albian age from Grave Creek, Jackson County, Oregon. Naming of this new species awaits better preserved material. Table 1 lists the discussed species by age and indicates their geographic distribution. Areas from which these eight species of aporrhaids have been collected are indicated on Figure 1.

Several recent papers have added to the number of aporrhaids described from the Cretaceous of the Pacific Slope. Popenoe (1983) defined the genus *Pyktes* and discussed species ranging in age from Turonian to Maastrichtian. Saul and Popenoe (1993) discussed two species of *Anchura (Helicaulax)* of Turonian age. Elder and Saul (1996) discussed 10 species of *Anchura* with ranges of 1.5 to 4 m.y. within the Late Cretaceous (Coniacian through Maastrichtian interval).

Popenoe (1983) proposed two subfamilies of Apor-

Table 1. Age and geographic distribution of discussed aporrhaid species.

Age	Species	California			Oregon
		S	C	N	
Turonian	*Alarimella anae* n. sp.	X			
	Alarimella veta (Packard, 1922)	X			
	Aporrhais drachuki n. sp.	X			
	Latiala californica (Gabb, 1864)		?	X	X
	Latiala nodosa (Packard, 1922)	X	?	X	
	Latiala sigma n. sp.			X	
Cenomanian	*Latiala heliaca* n. sp.		X	X	
Albian	*Latiala heliaca* n. sp			X	
	Latiala sp.				X

S = southern; C = central; N = northern. Juveniles at various horizons in the Great Valley Sequence on west side of the Great Valley, central California, resemble those of *L. californica*, *L. nodosa*, and *L. heliaca*.

rhaidae, Aporrhainae and Arrhoginae. Among characteristics of Aporrhainae mentioned by Popenoe are a prominent bent digitation on the wing at the shoulder, the digitation bent medially with its distal end posteriorly directed, additional labral digitations developed in some genera, and labral sinuses well developed. Characteristics of Arrhoginae include predominently axially directed sculpture, wing with an entire margin except for a prominent posteriorly directed digitation arising from the posteriolateral border of the outer lip, and, commonly, a straighter rostrum. *Aporrhais drachuki* exhibits characteristics of Aporrhaiinae. *Latiala* sp., *Latiala heliaca, L. californica, L. sigma,* and *L. nodosa* exhibit characteristics of Arrhoginae. Zinsmeister and Griffin (1995 added the subfamily Struthiopterinae for aporrhaids from the southern rim (Weddellian Province) of the Pacific Ocean. Roy (1994) suggested that *Struthioptera* might be an *Arrhoges* Gabb, 1868, but *Struthioptera* and other Struthiopterinae have two spiral carinae and *Arrhoges* lacks carinae. Roy (1994) used 25 morphologic characteristics and divided the Aporrhaiidae into two groups of genera, M1 with multidigitate apertural margins and M2 with simpler apertural margins. He includes *Aporrhais* in M1, and *Arrhoges,* of which *Latiala* Sohl, 1960, was proposed as a subgenus, is in M2.

Alarimella does not fit readily into the above subfamilies. Its elongate shape, short anterior rostrum, posterior canal extending up the spire, and its sculpture resemble those of *Rimella* and other *Rimella*-like gastropods (Clark and Palmer, 1923). *Alarimella* also resembles *Calyptraphorus binodiferus* Perrilliat and Vega, 1997, in its sculpture, but it lacks the callus coating and curled over posterior canal of *C. binodiferus* and has an expanded outer lip shaped somewhat like that of *Drepanocheilus.* The *Rimella*-like gastropods and *Calyptraphorus* are usually classed in the Strombidae from which *Alarimella* differs in having an alately expanded, internally channeled outer lip. *Alarimella* also lacks a strombid notch which perhaps suggests that its eyes were on bulbs at the base of the tentacles as in apporhaids rather than stalked as in strombids.

Temperature implications of the three genera, *Aporrhais, Latiala,* and *Alarimella,* are somewhat equivocal. Undoubtedly the climate of the Santa Ana Mountains during the Turonian was warm; rare rudist fragments are found associated with some of these aporrhaids. Modern *Aporrhais* spp., however, occur from the Baltic to North Africa, and modern *Arrhoges occidentalis,* arguably the closest living relative of *Latiala,* inhabits cool temperate waters from Newfoundland to North Carolina. As Cretaceous aporrhaids were much more widely distributed than are the modern ones, modern *Aporrhais* and *Arrhoges* may not appropriately model the climate for Cretaceous or early Tertiary species. *Latiala* is present in Japan in the Early Cretaceous, Pondoland, India, and the Gulf Coast during the latter part of the Cretaceous, and the Pacific Slope during the mid-Cretaceous, all in associations suggestive of warm water. *Rimella*-like gastropods are tropical to subtropical, and if *Alarimella* is related to them, it may indicate warm waters. The absence of *Latiala* in Pacific Slope post-Turonian deposits coincides with the absence of several other thermophilic molluscs (*e.g., Trigonarca, Anthonya,* and actaeonellid gastropods) that had been present in the mid-Cretaceous.

Table 1 contrasts some characteristics of the species discussed in this paper. The wing dimensions are described as tall to short in the axial direction (=height) and broad to narrow in the spiral direction (= breadth).

Institutional abbreviations used in this paper are: ANSP, Academy of Natural Sciences of Philadelphia; CASG, California Academy of Sciences, Geology; CIT, California Institute of Technology; LACMIP, Natural History Museum of Los Angeles County, Invertebrate Paleontology; UCBMP, University of California, Berkeley, Museum of Paleontology; UCLA, University of California, Los Angeles; USGS, United States Geological Survey; USNM, United States National Museum. Collections of California Institute of Technology and University of California, Los Angeles are at the Natural History Museum of Los Angeles County.

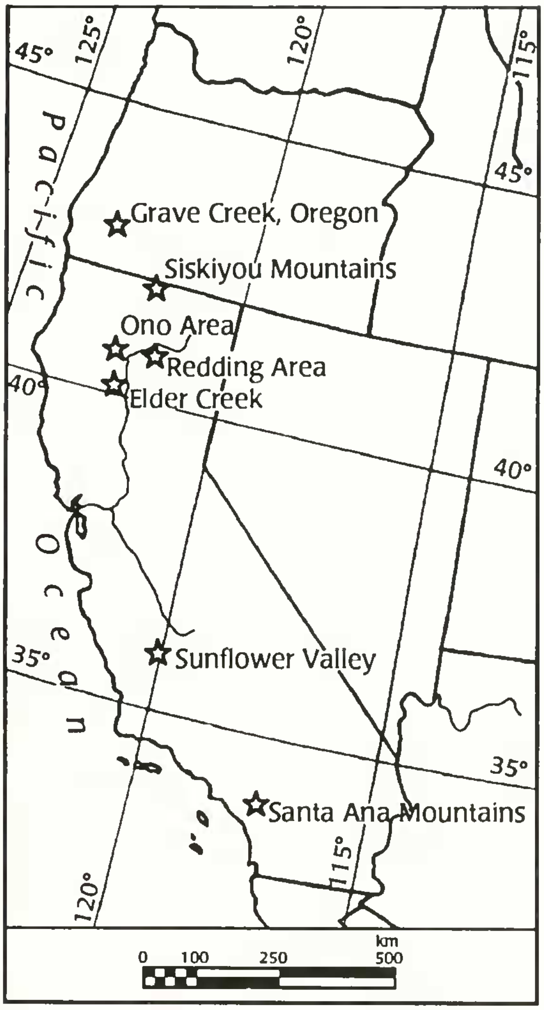


Figure 1. Index map to areas from which eight aporrhaiid species have been collected. **Grave Creek,** Jackson County, Oregon: ?Hornbrook Formation, late early-middle Albian. **Siskiyou Mountains,** Jackson County, Oregon and Siskiyou County, California: Osburger Gulch Sandstone Member of the Hornbrook Formation, Turonian. **Redding area,** Shasta County, California: Frazier Silt and Melton Sandstone Member, Redding Formation, Turonian. **Ono area,** Shasta County, California: Bald Hills Member, Budden Canyon Formation, Cenomanian. **Elder Creek,** Tehama County, California: fossiliferous boulder of Cenomanian or late Albian age in conglomerate of Turonian age. **Sunflower Valley,** Kings County, California: Panoche Formation, Cenomanian. **Santa Ana Mountains,** Orange County, California: Baker Canyon Sandstone and lower Holz Shale Members of Ladd Formation, Turonian.

SYSTEMATIC PALEONTOLOGY

Family Aporrhaidae Gray, 1850
Genus *Aporrhais* da Costa, 1778

Type species: *Aporrhais pespelicani* (Linnaeus, 1758), Recent, European seas.

Discussion: Aporrhais is a medium sized aporrhaid with a palmately expanded wing that has at least three digitations. The digitations are more or less spikey, short to long, and channeled interiorly. The posterior digitation may be very short and entirely adnate to the spire or longer and free for most of its length. The labral digitations of which there are at least two, vary both in number and length even within a species. Each digitation prolongs a cord from the last whorl. The protoconch is multispiral with globose, smooth whorls. The earliest sculpture is of fine spiral cordlets which are soon crossed by fine curved axial riblets. The riblets become stronger and commonly fewer and each develops a node medially. The row of nodes forms the whorl shoulder and commonly coincides with a strong cord as in *Aporrhais uttingeriana* (Risso, 1826). The whorl is subangulate, at least at the shoulder and basally, the more anterior angulation is also noded and/or cordate. The whorl profile between the angulations is commonly concave. At least one additional noticeable cord is commonly present anterior to the anterior angulation. It usually produces a digation in some species, rarely in others. The rostrum is commonly bent, adaperturally in some species, abaperturally in others and extended by a rostral digitation.

Aporrhais drachuki n. sp.
Figures 2–7; Table 3.

Diagnosis: An *Aporrhais* with two, nearly equal, strong, raised and noded primary cords on the body whorl, and a third somewhat weaker one on the base. Posterior-most cord forming carina on spire whorls.

Description: Shell average sized for *Aporrhais*, moderately high spired, pleural angle about 44°; about six post-nuclear whorls, angulate near mid whorl on spire, biangulate on body whorl; suture impressed; protoconch unknown; varices randomly present on early whorls; growth line antispirally concave on spire. Juvenile sculpture of fine collabral ribs; adolescent sculpture of about 20 rounded arcuate ribs, strongly noded at the mid whorl angulation; ribs greatly reduced on body whorl but producing strong nodes on posterior and anterior angulation; three nearly equidistant spiral cords on body whorl, strongest on posterior angulation and weakest anterior to anterior angulation; surface of body whorl covered by fine raised spirals, about three per mm, becoming stronger and fanning out onto wing; posterior and middle cords (primary cords) forming two angulations and digitations on wing. Outer lip expanded palmately to form wing. Inner lip with finger of callus extending adapically beyond the first suture, callus broad and rather thin parietally, thicker and with more defined edge at basal sulcus. Rostrum moderately short and narrow.

Type specimens: Holotype LACMIP 11373; paratypes LACMIP 11375 and 11376 from CIT loc. 1058 (=LACMIP loc. 10890), LACMIP 11374 from CIT loc. 1065 (=LACMIP loc. 10891), LACMIP 11377 from CIT 1064 (=LACMIP loc. 10893).

Type locality: LACMIP loc. 15295, south side of Sil-

Table 2. Some characteristics of discussed aporrhaid species. Measurements and ratios are averages from Tables 3–10.

	Posterior canal	Wing shape	WH/WB	A	Dp/Hp	R	Rj	C
Aporrhais drachuki n. sp	?	palmate	1.52 ± 0.26	41° ± 4.8	1.7 ± 0.2	10	24	3
Latiala n. sp.	no	quadrate	0.94 ± 0.1	30° ± 1.5	1.6 ± 0.2	8	20	0
L. heliaca n. sp	no	quadrate	0.90 ± 0.05	36° ± 3.2	2.0 ± 0.3	3–	28	0
L. californica (Gabb)	no	quadrate	0.76 ± 0.06	35° ± 4.0	1.9 ± 0.2	4–	40	0
L. sigma n. sp.	no	quadrate	0.83 ± 0.06	35° ± 3.2	1.8 ± 0.2	7	52	0
L. nodosa (Packard)	no	quadrate	1.12 ± 0.20	36° ± 4.2	1.0 ± 0.1	7	20	0
Alarimella anae n. sp.	yes	pointed	0.44	31° ± 2.3	1.8 ± 0.1	0?	14	0
A. veta (Packard)	yes	triangular	0.73 ± 0.15	26° ± 2.8	1.8 ± 0.2	14	?	

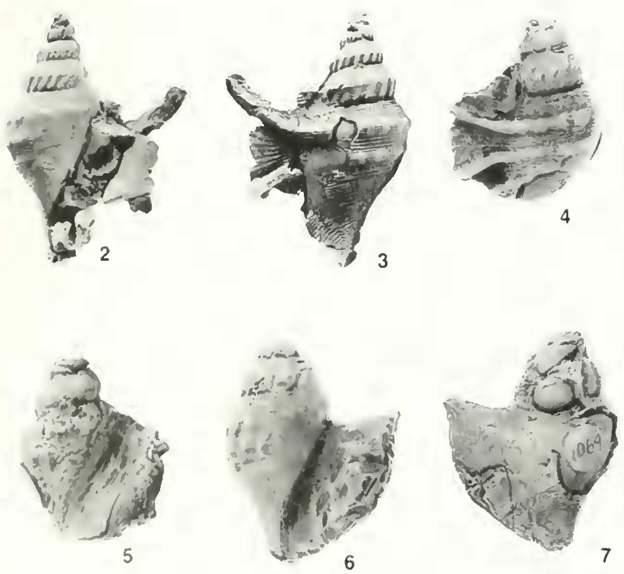
A = pleural angle; C = number of cords on body whorl; Dp/Hp = ratio of whorl diameter to whorl height; R = number of axial ribs on body whorl; – = ribs present only on back of whorl; Rj = number of axial ribs on juvenile whorl; WH/WB = ratio of wing height to wing breadth.

verado Canyon, 1025'N, 150'E of SW cor. sec.8, T5S, R7W, El Toro quadrangle, Santa Ana Mts., Orange County, California. Ladd Formation, top of Baker Canyon Sandstone Member; Turonian.

Dimensions: See Table 3.

Age: Late Turonian.

Geographic distribution: Known only from the Ladd Formation, Baker Canyon Sandstone and lower Holz Shale Members, Santa Ana Mountains, Orange County, California. (LACMIP loc. 15295, 1 spec; CIT loc. 1064, 1 spec.; LACMIP loc. 10898, 2 spec.; CIT loc. 1058, 3 spec.; CIT loc. 454, 1 spec.; CIT loc. 1065, 1 spec.; LACMIP loc. 10955, 2 spec.).



Figures 2–7. *Aporrhais drachuki* n. sp., all ×1 and whitened with ammonium chloride. **2–3.** Holotype LACMIP 11373 from LACMIP loc. 15295, **2,** aperture, **3,** back view. **4–5.** Paratype LACMIP 11375 from CIT 1058, **4,** back view, **5,** aperture. **6–7.** Paratype LACMIP 11377, from CIT 1064, **6,** aperture, **7,** back view.

Remarks: *Aporrhais drachuki* may be the earliest described *Aporrhais*. Wenz (1940) listed *Aporrhais* as Senonian (Europe) to Recent (Europe), but Roy (1994) depicts it as being present in the Cenomanian. Sohl (1967) reviewed North American species ascribed to *Aporrhais*. He concluded that *Aporrhais biangulata* (Meek and Hayden, 1856) of Maastrichtian age from the upper part of the Pierre Shale of Wyoming and Montana and an undescribed species of early Campanian age from the Blufftown Formation of Alabama were the only actual *Aporrhais* from the Cretaceous of North America known to him. Kase (*in* Kase and Maeda, 1980) described *Perissoptera elegans* Kase, 1980, of Barremian age, a species with an anterior digitation that is more spiky than lobate and not typical of *Perissoptera* Tate, 1865. The spiky labral digitations are suggestive of *Aporrhais*, but *P. elegans* appears to have no posterior digitation adnate to the spire. *Perissoptera elegans* is considerably earlier than *Aporrhais drachuki* and has characteristics that may be intermediate between *Drepanocheilus* and *Aporrhais*. *Aporrhais drachuki* differs from *A. biangulata* in having stronger nodes on its two prominent spiral cords, a more angulate whorl profile to the spire, and better developed axial ribs. In having a well noded adapical cord and noticeable third cord, *Aporrhais drachuki* is more similar to *A. pespelecani* than is *A. biangulata*. The primary spiral cords of *A. drachuki* are relatively stronger and the nodes on them less prominent; the two primary cords are more nearly equal (the posterior cord is only slightly stronger); and indications are for a posterior apertural digitaion that is much shorter than in *A. pespelecani*. The over all shape and sculpture pattern are very similar. The posterior edge of the outer lip in *A. drachuki* has a well developed posterior sinus that causes the lip edge to bend backward between the posterior adnate digitation and apparent posterior labral digitation. A complete distal edge to the wing is not preserved in any available specimen of *A. drachuki*. None of the specimens preserves a digitation adnate to the spire. Paratypes have extensions of callus adapically from the posterior end of the aperture that may be remnants of an adnate posterior digitation.

Table 3. Measurements in mm of specimens of *Aporrhais drachuki* n. sp.

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
LACMIP 11373	35.0	5.9	13.4	10.0	1.7	14.0†	47°	10	24	20	8.0†	12.5†	17.0	6
LACMIP 11374	17.6†	4.0	7.7	5.5	1.4	10.7†	34°	—	—	—	5.0	8.4	11.0	6
LACMIP 11376	20.8†	5.2	12.0†	9.0	1.7	—	44°	—	—	—	—	—	—	3+
LACMIP 11375	23.8†	5.5	14.5†	9.7	1.8	—	42°	—	—	—	9.6	16.0†	—	3
LACMIP 11377	29.9†	5.5	14.0	10.5	1.9	13.0†	42°	—	—	16•	13.0	14.8	19.6†	4

A = pleural angle; D = diameter last whorl; Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; † = broken, crushed; • = axial ribs counted on one side of whorl and doubled.

Roy (1994) suggests that in *Aporrhais* of Cretaceous age, the apertures are less heavily callused than in *A. pespelecani.* The holotype of *A. drachuki* is only lightly callused about the aperture, but it may not have been sufficiently mature to have developed a complete callus deposit. Paratype 11375 has a thicker callus deposit on the inside of the outer lip, but it, too, is not as thick as that of *A. pespelecani.*

Etymology: The species is named for Robert Drachuk, an amateur collector, who found the holotype of this species and donated it to W. P. Popenoe.

Genus *Perissoptera* Tate, 1865

Type species: *Rostellaria parkinsoni* Mantell, 1822, by subsequent designation, Cossmann, 1904. Albian, Europe.

Discussion: The genera *Perissoptera*, *Drepanocheilus* Meek, 1864, *Arrhoges* Gabb, 1868, *Latiala* Sohl, 1960, and *Graciliala* Sohl, 1960 (See Figure 8) have been considered to be closely related. Sohl (1960; 1967) placed *Perissoptera* and *Latiala* as subgenera of *Arrhoges*, and derived *Graciliala* from *Drepanocheilus.* Tate (1865), in proposing *Perissoptera* as a subgenus of *Aporrhais*, twice stated that the type species of a section of *Aporrhais* was *A. occidentalis* (Beck, 1836) (the species named by Gabb (1868) as type of *Arrhoges*) and wrote that this section corresponded with his new subgenus *Perissoptera*, which had characteristics intermediate between *Aporrhais* and *Alaria* Morris and Lycett, 1850. If Tate had actually designated *A. occidentalis* as type species of *Perissoptera*, his action would have preceeded Gabb's (1868) clear and unequivocal designation of *Chenopus occidentalis* (Beck, 1836) as type species of *Arrhoges*, and *Arrhoges* would be an objective junior synonym of *Perissoptera.*

Gabb (1868) commented upon Tate's paper in an addendum. He quoted Tate's "essential characters" of *Perissoptera* but considered it insufficiently distinct from *Anchura* Conrad, 1860, and did not mention that Tate had named *occidentalis* as type species of any group.

Gardner (1875, p. 51), who made no mention of Gabb's work, stated that Tate had designated *A. occidentalis* as type species of *Perissoptera.* Gardner argued, however, that there was no necessity for a supraspecific name for species better classed as *Aporrhais*, Group 1, and he did not use the binomen *Perissoptera occidentalis.* Gardner (1875) did not subsequently designate a type species for *Perissoptera* because he considered Tate to have named *A. occidentalis* as type species.

Cossmann (1904) recognized *Perissoptera* Tate as a useful taxon, in effect using it for Tate's Section I, *parkinsoni* group, and giving the type species as *Rostellaria parkinsoni* Mantell, 1822, Albian. Cossmann's footnote that refers to Tate's (1865) "fig. 18 (sub. nom. *Rost. Reussi*, non Gein.)" is part of the reference to Tate's proposal of the genus and apparently not part of Cossmann's designation of the type species. Cossmann (1904, p. 95) stated that his diagnosis of *Perissoptera* was based

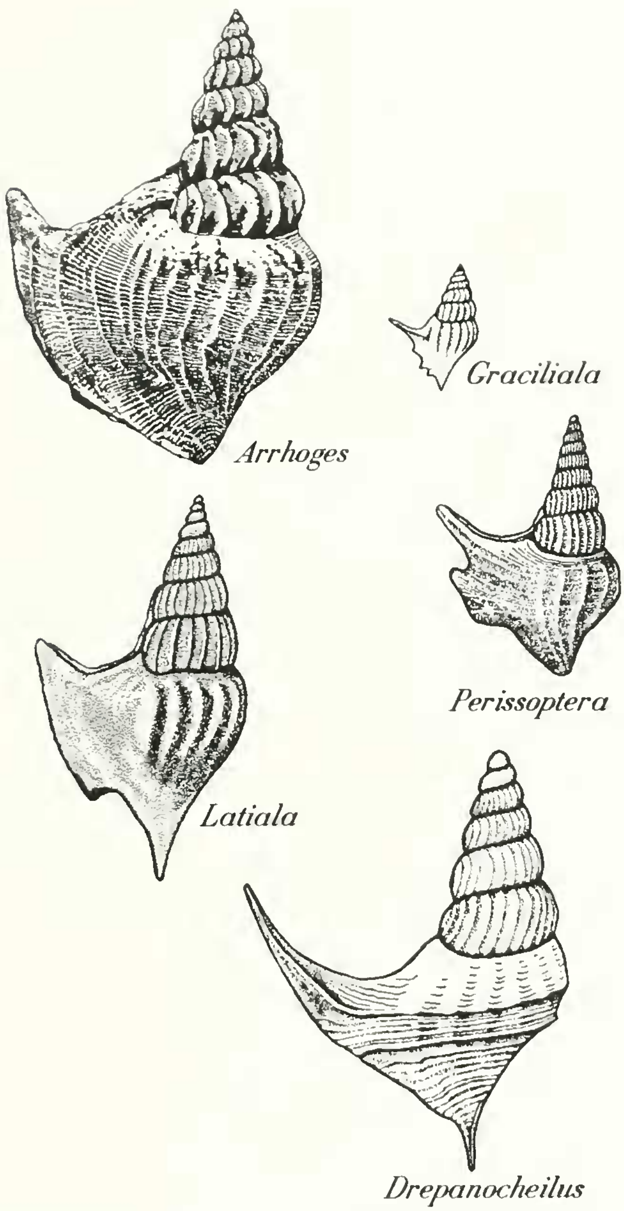


Figure 8. Line drawings of five aporrhaid genera, all ×1. Species serving as examples for the genera are: *Arrhoges occidentalis* (Beck, 1836), Recent, North Atlantic; *Graciliala calcaris* (Wade, 1926) Cretaceous, Gulf Coast; *Perissoptera parkinsoni* (Mantell, 1822), Cretaceous, England; *Drepanocheilus evansi* Cossmann, 1904, Cretaceous, Western Interior; *Latiala lobata* (Wade, 1926), Cretaceous, Gulf Coast.

on Gardner's (1875, pl. 66) figures of the type species and *Rostellaria marginata* Sowerby, 1836. *Rostellaria parkinsoni* Mantell, 1822, is the first species and *Rostellaria reussi* Geinitz, 1842, is the second species listed by Tate in his Section I, *Parkinsoni* group. Wenz (1940, p. 923) gave *Aporrhais (Perissoptera) reussii* Tate 1865 non Geinitz = *Rostellaria parkinsoni* Mantell as type of *Perissoptera*. Dockery (1993) gave the type species as *Rostellaria reussi* Tate original designation.

Tate (1865) did not directly designate any type species for *Perissoptera*. He wrote that *Aporrhais pespelecani* was the type species of the first section of *Aporrhais* and a second section of *Aporrhais* had for its type the living *A. occidentalis*., and later stated that *Perissoptera*, "intermediate between *Alaria* and *Aporrhais*, corresponds with that section of *Aporrhais* which has *A. occidentalis* as its type". In presenting his arrangement of the families Strombidae and Aporrhaiidae he included in Aporrhaiidae "the extinct genera *Alaria*, *Diarthema*, and *Perissoptera*." As Tate considered *Perissoptera* to be extinct, the Recent *A. occidentalis* could hardly "serve as" its type species.

Tate divided his new subgenus *Perissoptera* into three sections: Section I. *Parkinsoni* group; Section II. *Calcarata* group; and Section III. *Glabra* group. Tate's topic was the classification of Rostellariae of the Cretaceous rocks, and, as might be expected, *A. occidentalis*, a Recent species, is not included in any of Tate's three sections of *Perissoptera*. Thus, Tate not only did not directly designate *occidentalis* as type species of *Perissoptera*, but he actually excluded it as a possible type species by characterizing *Perissoptera* as extinct, and he did not list *A. occidentalis* among the species he included within *Perissoptera*.

Mantell (1822) provided the name *Rostellaria parkinsoni* for a specimen from the Albian of Blackdown figured by Parkinson (1811), but he also referred to a specimen of early Cenomanian age from the Grey Chalk. Tate (1865) mistakenly indicated that the Blackdown specimen was from the Grey Chalk and referred specimens from the Blackdown Greensand to *Aporrhais (Perissoptera) reussii* (Geinitz, 1842), but these are not *reussi* of Geinitz which is from the Baculitenschichten of Zatschke and is of Turonian age (Kollmann, 1978). Kollmann (1978) reviewed *Perissoptera parkinsoni*, discussed its occurrence, and considered the most repeated figure perporting to be *P. parkinsoni* (Mantell) (*i.e.*, Gardner, 1875, pl. 6, fig. 4; Wenz, 1940, p. 924, fig. 2705; etc.) to be an undescribed species, but both Kollmann (1978) and Tate (1865) quoted the same figures of Mantell (1822, pl. 18, fig. 1, 4, 5, 10) as being *Perissoptera parkinsoni* (Mantell, 1822).

Perissoptera has been widely used for moderately high spired aporrhaids having the axial sculpture much stronger than the spiral, and an expanded outer lip that is drawn out at its posterior extremity into a blade set off from the lobate medial distal margin by a sinus (Figure 8). The type species has a relatively short and wide rostrum and is moderately carinate on the last whorl. Included within *Perissoptera* are species with a longer rostrum and stronger spiral sculpture than are in *Arrhoges*, as well as a distinctive outer lip drawn out posteriorly and channeled interiorly. *Perissoptera* differs from *Latiala* in usually having the spiral sculpture stronger and in having the outer lip sinused on its distal margin, just anterior to the posterior extension, which is channeled interiorly.

Perissoptera occurs more commonly in Europe than

in America, although the genus is present in the Western Interior (*Perissopteria prolabiata* (White, 1876), Cenomanian) and the Gulf Coast (*Perissopteria prolabiata mississippiensis* Dockery, 1993, Campanian). The only species described from Pacific Slope deposits is *Perissoptera hannai* (Allison, 1955) from the Aptian-Albian Alisitos Formation of northern Baja California, Mexico.

Genus *Latiala* Sohl, 1960

Type species: *Anchura lobata* Wade, 1926, by original designation. Maastrichtian of the Gulf Coast of North America.

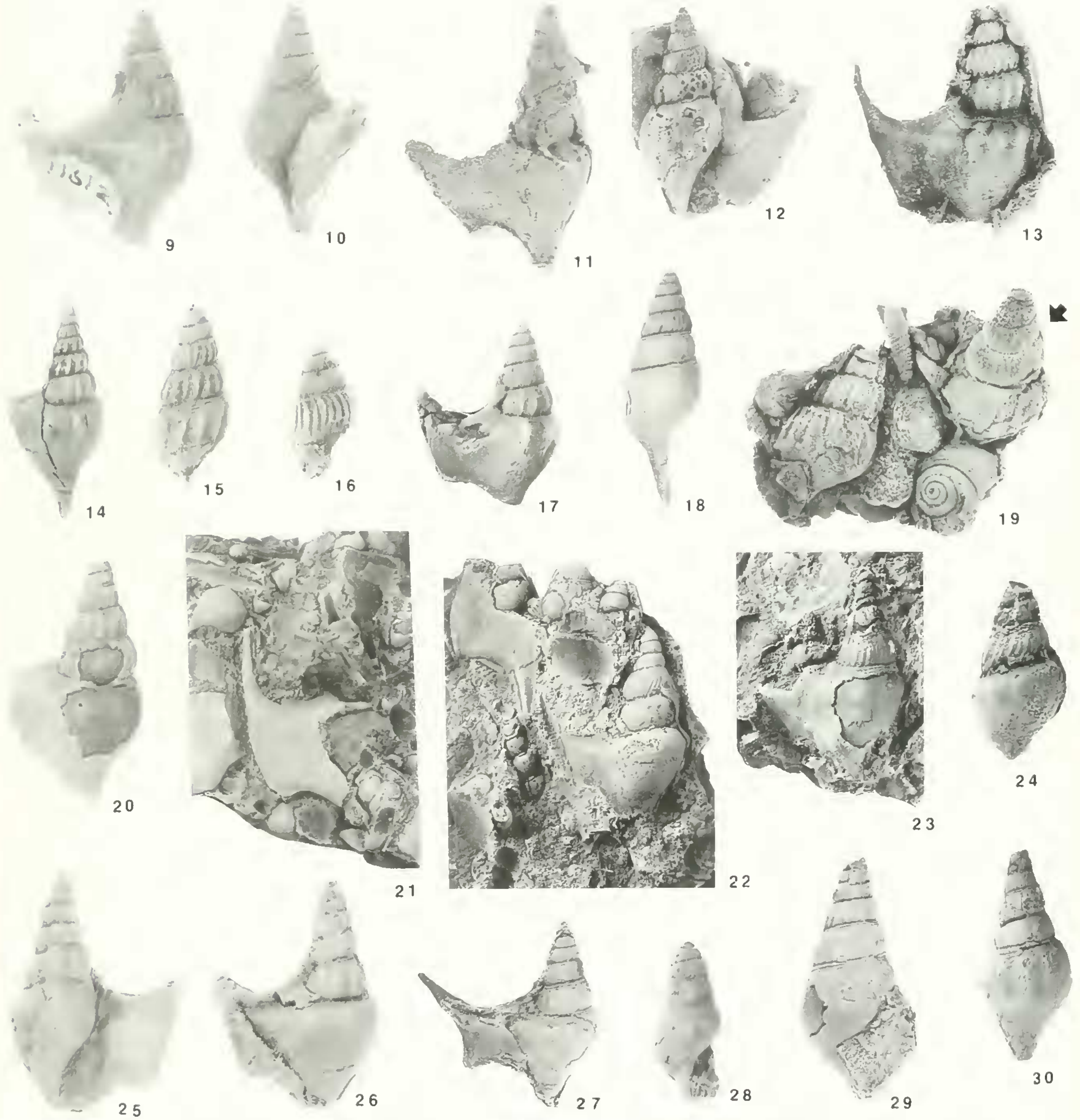
Discussion: Sohl (1960) differentiated *Latiala* from *Arrhoges* on the basis of *Latiala*'s broad, thick outer lip which is thickened and lobed at the anterior and posterior termini of its distal margin, the more pointed and longer lobe directed posteriorward and the blunter one directed anteriorward. He found *Latiala* to be widely distributed (*i.e.*, New Jersey, Tennessee, Mississippi, Texas, India, and South Africa) during the late Late Cretaceous. Abdel-Gawad (1986) has added *Latiala pelecyphora* (Kaunhowen, 1897) of late Maastrichtian age from the Middle Vistula Valley of Poland. Pacific Slope species resembling *Latiala* are, however, of Albian through Turonian age, and Kase (1984) reported Japanese *Latiala* of Aptian-Albian age. In Pacific Slope sediments, juvenile shells are more common and more abundant, especially in fine-grained, more off-shore deposits, than are the mature shells. Juvenile shells of *Latiala* appear to have been more readily transported into deeper water than shells of other gastropods with which the adult *Latiala* spp. are associated. Popenoe (1983), in assigning Pacific Slope specimens to *Latiala*, discussed only *A. (L.) californicus*, in which he included "*Alaria*" *nodosa* Packard and some specimens herein assigned to *L. heliaca* n. sp. and *L. sigma* n. sp.

Dockery (1993, p. 61) raised *Latiala* to a genus based on its having a thinner, more fragile shell than that of *Arrhoges*, a helicocone similar to that of *Graciliala*, and a body whorl without fine spiral lirae, but Roy (1994) did not separate *Latiala* from *Arrhoges*. Unlike *Graciliala*, but as in *Arrhoges*, the wing of *Latiala* is usually unchanneled. Specimens of *Latiala lobata* (Wade) from Coon Creek, Tennessee, show fine spiral striae under sufficient magnification even on the body whorl, but sculpture of Pacific Slope species does differ from that of the type species in having a few noticeably stronger lirae adjacent to the posterior suture. The Pacific Slope species herein assigned to *Latiala* vary in shell thickness; *L. californica* is thin shelled enough to meet Dockery's specifications, but *L. nodosa* has a thicker shell that is not more fragile than that of *Arrhoges*. All of these species have some development of spiral lirae on the body whorl, but in *L. californica* the lirae are so fine, and in *L. nodosa* the preservation of most specimens is sufficiently poor, that the lirae are commonly obliterated. *Latiala heliaca* has the strongest lirae, but they are not as strong as those of *Arrhoges occidentalis*. *Latiala heliaca* and *Latiala* sp. from Grave Creek are more slender and have a longer rostrum than *Arrhoges*. Of the five Pacific Slope *Latiala* species considered here, *L. nodosa* is most similar to *Arrhoges* in its stocky shape and thicker shell, but *L. nodosa* has the anterior and posterior wing extensions of *Latiala*, and its shape is similar to that of the thin shelled *L. sigma*, which has the longer rostrum and longer posterior wing extension of a *Latiala*. The most notable difference between these five species of *Latiala* lies in the sculpture of the spire and especially in the number and placement of axial ribs. A common feature of these species is the sculpture pattern on the spire of arched, somewhat opisthocline ribs crossed by fine spirals, a few of which are strongest adjacent to the posterior suture.

This sculpture pattern is one of the features that *Latiala* shares with, at least some species of *Perissoptera* Tate, 1865. In its early whorls, sculpture, and shape, exclusive of the wing, *Latiala* resembles *Perissoptera*. Wing development of more than one *Perissoptera* species passes through a stage in which the shape of the wing outline resembles that of *Latiala* or *Arrhoges*. A small specimen (Figures 9–10) in the LACMIP collections labeled *Perissoptera robinaldina* (d'Orbigny, 1843) from the Aptian of Atherfield, Isle of Wight, Great Britain (LACMIP loc. 11612), resembles Gardner's, 1875, pl. 7, fig. 11 of *P. robinaldina*. The distal margin of its wing is thickened anterior to a slight sinus at the base of the posterior wing digitation.

Although Sohl (1960) and Roy (1994) include *Latiala* as a subgenus of *Arrhoges*, and Sohl (1960) derives *Arrhoges* from *Drepanocheilus*, the species placed in *Latiala* by Kase (1984) and herein, suggest that *Latiala* appears in the geological record before *Arrhoges*, and *Arrhoges* might more reasonably be derived from *Latiala*. Dockery (1993) notes that the helicocones of *Graciliala* and *Latiala* are similar, but that *Graciliala* has a channeled outer lip and *Latiala* does not, a feature that lends support to Roy's (1994) placement of *Graciliala* nearer to *Drepanocheilus* than to *Arrhoges*. *Drepanocheilus* and *Perissoptera* have both been recorded from the Barremian by Roy (1994) and Kase (1980 in Kase and Maeda; but see remarks on *Perissoptera elegans* under *Aporrhais drachuki*) respectively; *Latiala* is first recognized in the Aptian (Kase, 1984); *Graciliala* apparently is known only from the Campanian and Maastrichtian; Sohl (1960) indicated that Cretaceous forms classed as *Arrhoges* belong either to *Latiala* or *Perissoptera*, and *Arrhoges* is present in the Paleocene (Kollmann and Peel, 1983).

Popenoe (1983) assigned *Latiala* from the Santa Ana Mountains to *Arrhoges (Latiala) californicus* which was described from the Siskiyou Mountains (Gabb, 1864). He also included in *A. (L.) californicus* specimens of Cenomanian to Turonian age which show considerable variation in number of axial ribs, height of spire, strength of spiral lirae, and length of rostrum. He evidently intended further study of this group as he had on hand



Figures 9–30. All whitened with ammonium chloride. **9–10.** *Perissoptera robinaldina* (d'Orbigny, 1842), hypotype LACMIP 11536, from Atherfield, Isle of Wight, Great Britain, ×2, **9,** back view, **10,** apertural view showing wing edge. **11–13, 19.** *Latiala* sp., all ×2, latex pulls from LACMIP loc. 24670, **11,** LACMIP 7969, back view, **12,** LACMIP 7968, apertural view, **13,** LACMIP 7966, back view, **19,** two specimens, arrow points to LACMIP 7967. **14–18, 20–21.** *Latiala heliaca* n. sp., **14,** holotype LACMIP 11378 from LACMIP loc. 28788, ×1, back view, **15,** paratype LACMIP 11379 from LACMIP loc. 28788, ×3, back view, **16,** paratype LACMIP 11380 from LACMIP loc. 28788, ×4, protoconch and first juvenile whorl, **17,** paratype LACMIP 11382 from LACMIP loc. 16838, ×2, back view, **18,** paratype LACMIP 11383 from LACMIP loc. 16838, ×2, left side, **20,** paratype 11381 from LACMIP loc. 16838, ×2, back view, **21,** paratype 11384 from LACMIP loc. 16838, ×2, wing in rock containing abundant *L. heliaca*. **22–30.** *Latiala californica* (Gabb), **22,** lectotype ANSP 4772 from the Siskiyou Mountains?, ×2, photo by T. Susuki, **23,** paralectotype ANSP 4772 from the Siskiyou Mountains?, ×2, photo by T. Susuki, **24,** hypotype LACMIP 11390 from LACMIP loc. 10901, ×2, back view, **25–26,** hypotype LACMIP 11388 from LACMIP loc. 10901, ×2, **25,** apertural view, **26,** back view, **27,** hypotype LACMIP 11385 from UCLA loc. 4365, ×2, back view, **28,** hypotype LACMIP 11387 from UCLA loc. 4365, ×3, apertural view, **29,** hypotype LACMIP 11386 from UCLA loc. 4365, ×2, apertural view, **30,** hypotype LACMIP 11389, from LACMIP loc. 10901, ×1.5, back view.

Table 4. Measurements in mm of specimens of *Latiala* sp.

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
LACMIP 7966	18.2	3.3	—	—	—	9.1	—	—	18•?	15?	7.9	7.8	13.3	4
LACMIP 7628	19.0	3.0	—	—	—	10.0	30°	—	20•?	21?	6.5	—	—	5
LACMIP 7967	15.4	3.9	8.0	5.8	1.5	8.0	31°	8	21	24•	—	—	—	4
LACMIP 7969	20.5	3.8	—	6.8	1.8	11.0	28°	—	—	—	7.8	6.9	9•+	6

A = pleural angle; D = diameter last whorl; Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; † = broken, crushed; • = axial ribs counted on one side of whorl and doubled.

specimens of Cenomanian age from Clear Creek, Shasta County, and Sunflower Valley, Fresno County, that he had labeled *Arrhoges* (*Latiala*) new species. Specimens of *Latiala* of Turonian age from the Santa Ana Mountains reveal differences in the sculpture of the early whorls and in onset of sculpture changes on the spire, as compared to specimens of *L. californica* from the Siskiyou Mountains of the Oregon California border. On the basis of these differences, *L. californica* is discriminated from *L. nodosa* and considered not to be found in southern California.

Latiala sp.

Figures 11–13, 19; Table 4.

Diagnosis: A fusiform *Latiala* with about 18–24 axial ribs on spire whorls, reduced to about eight on body whorl; body whorl with ribs not confined to back of whorl.

Description: Shell of medium size, spindle shaped, except for expanded outer lip; whorls about twice as wide as high, numbering about seven or eight whorls, last whorl approximately half of shell height; pleural angle about 30°; whorl profile on spire roundly convex; profile of last whorl roundly convex except at axial nodes; outer lip expanded, broad, subquadrate, with short anterior and longer more pointed posterior projection. Protoconch unknown. Sculpture of 18–24 arched, round-topped, axial ribs, crossed by much weaker, fine spiral cordlets, strongest adjacent to posterior suture, two cordlets commonly strongest; sculpture on body whorl of eight to nine, short sharp, strong axial ribs crossed by fine spiral cordlets; ribs on back of body whorl shorter, stronger, more nodular. Aperture elongate; inner lip thickly callused with well defined edge; rostrum narrow, of moderate length.

Material examined: LACMIP 7628, 7966–7969 from LACMIP loc. 24670 on Grave Creek, Jackson County, Oregon.

Dimensions: See Table 4.

Age: Late early to middle Albian.

Geographic distribution: Studied specimens are all from the Hornbrook ? Formation on Grave Creek, Jackson County, Oregon

Remarks: This undescribed species is left unnamed because the specimens studied are all rock molds, and the figures are from latex pulls. The protoconch was present on some of these specimens, but the sandstone is too coarse-grained to yield a latex pull that replicates the original surface. Sculpture of the spire is similar to that of *Latiala hayamii* (Kase, 1984), but *Latiala* sp. has a broader pleural angle. *Latiala* sp. differs from *L. heliaca* in having more axial ribs on the body whorl, some of which are on the apertural side of the whorl. *Latiala* sp. has a proportionately higher wing than *Latiala heliaca*, *L. californica*, or *L. sigma*.

Table 5. Measurements in mm of specimens of *Latiala heliaca* n. sp.

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
LACMIP 11378	34.1	4.6	—	8.9	1.9	16.0	35°	—	19	14	—	—	—	8
LACMIP 11379	9.7	1.9	5.0	4.2	2.2	—	34°	—	26•	—	—	—	—	7
LACMIP 11380	5.5	0.8	2.7	2.0	2.5	2.5	43°	—	38	—	—	—	—	5
UCLA 28625	20.5	3.3	9.6	7.0	2.1	11.6	32°	3	—	—	10.4	9	10	7
UCLA 28626	13.7	3.4	7.0	5.4	1.6	13.7	36°	—	30	17	—	—	—	9
LACMIP 11381	19.2	3.3	8.4	6.0	1.8	9.8	35°	3	—	—	—	—	—	5
LACMIP 11382	14.5	2.4	6.8	4.9	2.0	6.0	35°	2	—	14	6.6	5.5	7.0	6
LACMIP 11383	17.0	2.7	6.8	5.2	1.9	8.6	34°	—	28•	—	—	—	—	8
LACMIP 11384	—	—	—	—	—	—	—	—	—	—	7.8	7.3	14.8	—

A = pleural angle; D = diameter last whorl; Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; • = axial ribs counted on one side of whorl and doubled.

Latiala heliaca n. sp.
Figures 14–18, 20–21; Table 5.

Arrhoges californicus (Gabb)—Murphy and Rodda, 1960, p. 841, pl. 102, fig. 6–7.

Diagnosis: A slender fusiform *Latiala* with about 16 axial ribs on spire whorls, greatly reduced on final whorl to two or three on dorsal side of body whorl.

Description: Shell of medium size, spindle shaped, except for expanded outer lip, of about nine whorls; whorls about twice as wide as high; last whorl approximately half of shell height; pleural angle about 36°; whorl profile on spire roundly convex; profile of last whorl roundly convex except at axial nodes and with broad axial bulge on apertural face; outer lip expanded, broad, subquadrate, slightly thickened at distal edge, with short anterior and longer posterior projections. Protoconch of four or five rapidly enlarging, rounded, glossy whorls; transition to juvenile sculpture gradual, marked by spaced faint, arched, axial ribs and spiral striae; ribs rapidly strengthened, becoming crowded. Sculpture on first juvenile whorl of 26–36 arched axial ribs crossed by much weaker fine spiral cordlets; sculpture of next through penultimate whorls of about 16 arcuate axial ribs crossed by fine spiral cordlets, strongest adjacent to posterior suture, three cordlets commonly strongest; sculpture on body whorl of three to four short, sharp, strong axial ribs crossed by fine spiral cordlets. Aperture elongate; inner lip broadly callused, callus angling from posterior of aperture across mid-whorl on apertural face and wrapping halfway around anterior rostrum; rostrum narrow, straight, relatively short.

Type specimens: Holotype, LACMIP 11378. Paratypes LACMIP 11379–11380 from LACMIP loc. 28788; UCLA 28625 = LACMIP 9825 , UCLA 28626 = LACMIP 9824 from UCLA loc. 3465, and LACMIP 11381–11384 from LACMIP loc. 16838, Ono area, Shasta County, California.

Type locality: LACMIP 28788, north end of Sunflower Valley (=McLure Valley), Fresno County, California. Panoche Formation.

Dimensions: See Table 5.

Age: ?Late Albian-Cenomanian.

Geographic distribution: Budden Canyon Formation, Bald Hills Member, Ono area, Shasta County (UCLA loc. 3465; Great Valley Series, Elder Creek, Tehama County (LACMIP loc. 24370); Panoche Formation, Sunflower Valley, Fresno County (LACMIP loc. 28788), California.

Remarks: No varices were recognized on the early whorls of *L. heliaca*. LACMIP 11380 consists of a protoconch of 4 polished, rounded whorls and the first teleoconch whorl. The earliest axial ribs are irregular, low, and difficult to count, but on the second quarter of the first teleoconch whorl the ribs become stronger, more distant and more regular. Rib strength varies between

Table 6. Measurements in mm of specimens of *Latiala californica* (Gabb).

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
ANSP 4272	15.0	2.0	5.0	3.9	1.95	7.0	?	—	40	—	4.7	3.8	7.0	7
CASC 61950.01	10.65		6.15											
CASC 61950.02	22.26													
LACMIP 11385	14.8	2.0	6.0	4.7	2.35	7.0	42°	3	30+	—	7.0	5.0	6.5	7
LACMIP 11386	19.7	3.8	8.5	6.5	1.76	11.0	30°	4	—	20	—	—	—	6
LACMIP 11387	8.9	1.8	4.3	3.3	1.83	—	33°	—	§	—	—	—	—	6
LACMIP 11388	18.3	3.4	7.9	6.0	1.76	10.0	35°	3	—	14?	8.8	6.9	9.0	8
LACMIP 11389	22.3	3.4	9.6	6.9	2.03	10.5	34°	4	60?	—	—	—	—	5
LACMIP 11390	14.0	3.4	7.0	5.7	1.7	8.0	34°	3	—	22	—	—	—	4

A = pleural angle; D = diameter last whorl; Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; § = ribs too fine to count.

individuals, and on some whorls the axial ribs may be indiscernible.

Specimens from Elder Creek (LACMIP loc. 24370) are from a boulder containing species suggestive of late Albian age in a conglomerate that is of Turonian age (Jones and Bailey, 1973).

Latiala heliaca is larger and more slender than *L. californica* and has fewer axial ribs. Whereas *L. californica* retains the fine axial ribbing of the juvenile whorl throughout most of the spire whorls, in *L. heliaca* the intermediate whorls have fewer, coarser ribs, and the body whorl is not angulate at the shoulder, although the nodose axial ribs can create the impression of a shoulder angulation. *Latiala helica* has more axial ribs on the spire and fewer on the body whorl, is more slender with a more fuisform shape, and has a slightly broader shorter wing than *L. nodosa*. *Latiala helica* is more slender, has less of a shoulder, fewer axial ribs, and a shorter wing than *L. sigma*.

Latiala heliaca is most similar in shape to *Latiala hayamii* (Kase, 1984) from the Aptian-Albian of northeast Japan, but differs in having fewer axial ribs on the body whorl.

Etymology: The species name, derived from Greek, *helios*, sun, refers to the type locality at the northwest end of Sunflower Valley.

Latiala californica (Gabb, 1864)
Figures 22–30; Table 6.

Aporrhais californica Gabb, 1864, p. 128, pl. 29, figs. 230a, b.
Arrhoges californicus (Gabb)—Stewart, 1927, p. 363, pl. 21, fig. 15.
Arrhoges (*Latiala*) *californicus* (Gabb). Popenoe, 1983, p. 761 (in part; not fig. 6F, 1 See *L. nodosa* Packard).
Not *Arrhoges californicus* (Gabb)—Murphy and Rodda, 1960, p. 841, pl. 102, fig. 6–7. See *L. heliaca* n. sp.
Not *Arrhoges californicus* (Gabb)—Jones, Sliter and Popenoe, 1978, p. xxii.9, pl. 1, fig. 10. See *L. nodosa* Packard).

Diagnosis: A small *Latiala* in which axial sculpture of spire consists of fine, closely spaced, almost sigmoid ribs. Sculpture of body whorl of three to four strong, short ribs, present only on dorsal side, nodular at the shoulder.

Description: Shell, thin, of small to medium size, spindle shaped except for expanded outer lip; whorls nearly twice as wide as high, numbering about seven; last whorl approximately two-thirds to three-quarters of shell height; pleural angle about 35°; whorl profile on spire rounded; profile of last whorl angulate at shoulder and with broad axial bulge on apertural face; varices rare (?one juvenile varix per specimen), forming broad axial swellings; outer lip expanded, broad and moderately tall, with very short anterior and much longer posterior projections. Protoconch multispiral of five or six smooth, rounded whorls. Sculpture on body whorl of about four short, nodular axial ribs on dorsal side, a broad axial bulge on the apertural side and fine spiral striae, stronger spiral cordlets on shoulder and on collar; sculpture

on penultimate whorl of about 20 fine nearly sigmoid axial ribs and fine (about four per mm), regularly spaced spiral cordlets, strongest near posterior suture; sculpture on earlier whorls finer than on penultimate whorl. Aperture elongate, outer lip thickened internaly; distal edge of outer lip relatively long; rostrum short.

Type specimens: Lectotype ANSP 4272 (designated by Murphy and Rodda, 1960). Paralectotypes (2) ANSP 79470; CASG 61950.01 (one loose specimen + a rock fragment containing several, two largely exposed).

Hypotypes: LACMIP 11385–11388 from UCLA loc. 4365, Redding area, Shasta County; and LACMIP 11388–11390 from LACMIP loc. 10901, Rancheria Gulch, Siskiyou County, California.

Type locality: Siskiyou Mountains?, Jackson County, Oregon or Siskiyou County, California. Gabb (1864, p. 129) listed this species from "Orestimba Cañon; Martiñez; Puerto Cañon, Stanislaus County; Siskiyou Mountains." None of these was precise as to geographic or stratigraphic position. Stewart (1927) said that the label with Gabb's ANSP specimens read Siskiyou Mts. and Martinez, but that all of the specimens were in a similar black limestone matrix with small pebbles which he considered more likely to have come from the Siskiyou Mountains than from Martinez. Natural History Museum of Los Angeles County specimens resembling Gabb's material are from the Osburger Gulch Sandstone Member of the Hornbrook Formation in the Siskiyou Mountains, but are not identical in preservation to Gabb's Siskiyou Mountains specimens.

Dimensions: See Table 6.

Age: Turonian.

Geographic distribution: Hornbrook Formation, Osburger Gulch Sandstone Member (LACMIP loc. 10901, LACMIP loc. 10876, LACMIP loc. 25422), Jackson County, Oregon and Siskiyou County, California; Redding Formation, ?Frazier Siltsone Member (UCLA 4365) near Redding, Shasta County, California.

Remarks: The CASG "syntypes" have a label that lists SUT 266, Calif. Geol. Surv. 2144, and UCB 14907, indicating that the specimens were originally at University of California, Berkeley, Museum of Paleontology before they were moved to Stanford and from there to the California Academy of Sciences.

The lectotype is 15 mm high, nearly complete, and has an adult aperture, but is missing shell on the last two whorls. The absence of parts of the shell interfers with describing the sculpture. The ANSP and CASG type specimens are small, but some collections (*e.g.*, LACMIP loc. 10901) contain a few larger individuals (Figure 30). The above description depends in part on additional specimens from the rather generalized type locality of Siskiyou Mountains. Specimens are commonly found locally in abundance as in the blocks of paratype material, but the very thin shell of this species has made difficult the recovery of specimens with shell adhering. This species exhibits juvenile sculpture onto the penultimate whorl on small adults and up to the penultimate whorl on large adults.

Gabb's illustration (fig. 230a) has an outline more like that of *Latiala heliaca* than of *L. californica* and may have been based on a specimen of that species. If so, the specimen appears to have been lost.

Latiala californica differs from *L. heliaca* in having an angulate shoulder and more axial ribs on most whorls. It differs from *L. nodosa* in having a very thin shell, retaining the fine axial ribbing onto or up to the penultimate whorl. *Latiala californica* is smaller, has weaker spiral sculpture, and fewer axial ribs on the body whorl than *L. sigma*. Of the five species discribed in this paper, *L. californica* has the relatively shortest wing.

Latiala sigma n. sp.
Figures 31–43; Table 7.

Diagnosis: A relatively large *Latiala* with relatively strong spiral sculpture, numerous fine axial ribs on early whorls, and about seven ribs on body whorl.

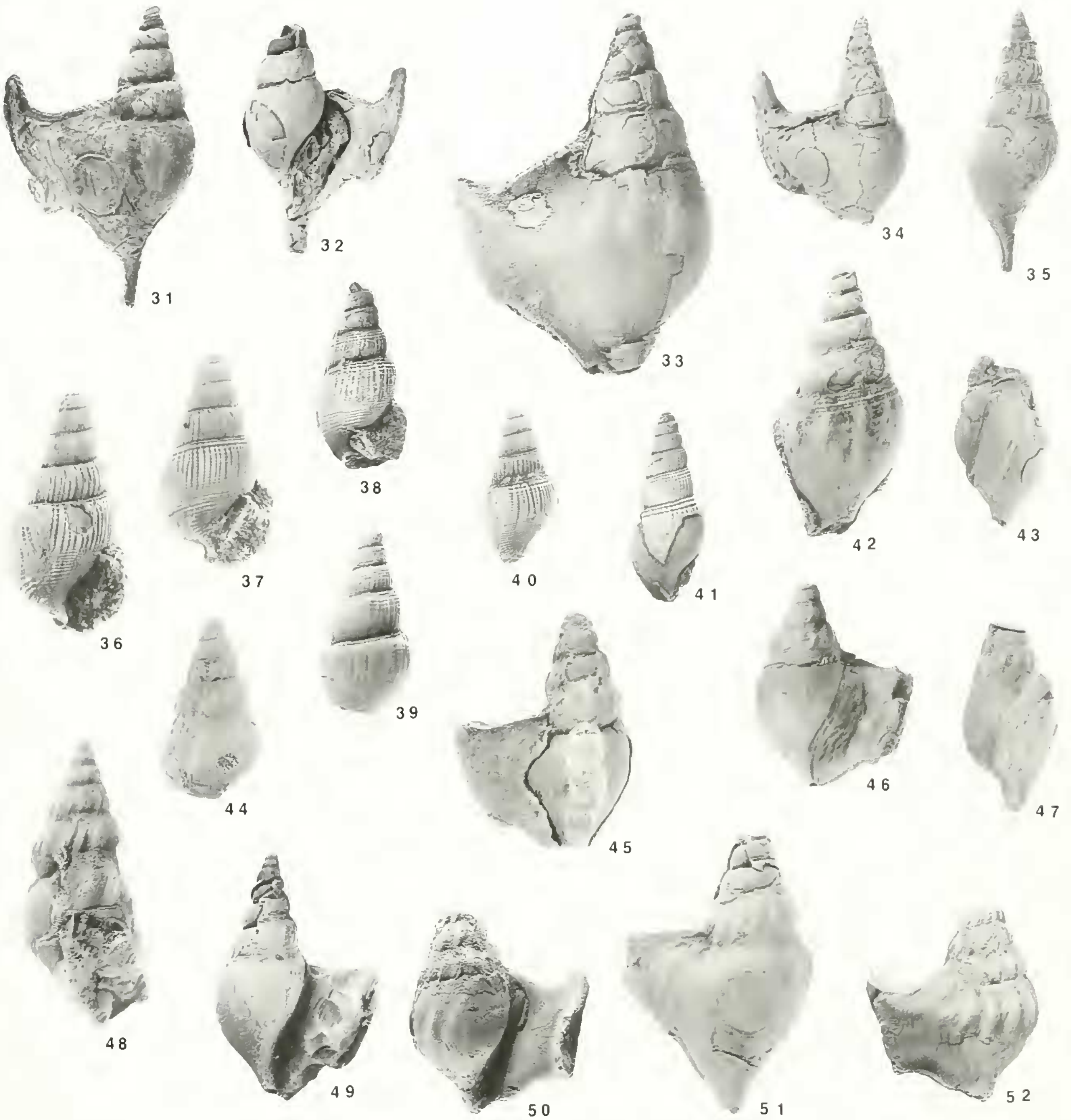
Description: Shell of medium size, stoutly spindle shaped, except for expanded outer lip; whorls about twice as wide as high, nine in large mature individuals, seven in small mature individuals; last whorl approximately two-thirds of shell height; pleural angle about 36°; whorl profile on spire nearly flat sided with narrow rounded shoulder; whorl profile of last two whorls rather evenly rounded; varices poorly developed on early whorls; outer lip expanded, tall and broad, subquadrate with very short, blunt anterior and narrow posterior projections; angle of distal edge of outer lip to that of shell axis about 33°. Protoconch of four rounded, glossy whorls. Sculpture on winged body whorl of five to seven short axial ribs on dorsal side, on penultimate whorl of about 20 to 30 curved axial ribs and three narrow spiral cordlets at the suture; sculpture on first quarter of first teloconch whorl of fine axial lines, at least eight per 1 mm, axial lines double in size and by third teleoconch whorl are four to 1 mm; second teleoconch whorl with about 40–50 fine axial ribs crossing about 20 spiral cordlets; cordlets weakest mid whorl and strongest posteriorly. Aperture elongate, outer lip not much thickened; inner lip somewhat thickened; rostrum relatively long.

Type specimens: Holotype LACMIP 11391. Paratypes LACMIP 11392–11398 from UCLA loc. 5421, LACMIP 11399–11401 from CIT 1346, and LACMIP 11402 from CIT 1266, all on Little Cow Creek, Redding area, Shasta County, California.

Type locality: UCLA loc. 5421, Little Cow Creek, south line sec. 9, T32N, R3W, Millville quad., Shasta County, California. Redding Formation, Melton Sandstone.

Dimensions: See Table 7.

Age: Turonian.



Figures 31–52. All whitened with ammonium chloride. **31–43.** *Latiala sigma* n. sp., **31,** holotype LACMIP 11391 from UCLA loc. 5421, ×1.5, back view, **32,** paratype LACMIP 11392 from UCLA loc. 5421, ×1, apertural view, **33,** paratype LACMIP 11400 from CIT loc. 1346, ×1.5, back view, **34,** paratype LACMIP 11393 from UCLA loc. 5421, ×1, back view, **35,** paratype LACMIP 11402 from CIT loc. 1266, ×1.5, showing juvenile to mature sculpture, **36,** paratype LACMIP 11396 from UCLA loc. 5421, ×4, protoconch and two juvenile whorls, **37,** paratype LACMIP 11398 from UCLA loc. 5421, ×4, protoconch and two juvenile whorls, **38–39,** paratype LACMIP 11394 from UCLA loc. 5421, ×2, juvenile whorls, **40,** paratype LACMIP 11397 from UCLA loc. 5421, ×3, protoconch, two juvenile whorls, and a varix, **41,** paratype LACMIP 11395 from UCLA loc. 5421, ×2, protoconch and three juvenile whorls, **42,** paratype LACMIP 11401 from CIT loc. 1346, ×1.5, showing mature sculpture on last whorl, **43,** paratype LACMIP 11417 from UCLA loc. 5421, ×1, angle of outer lip. **44–52.** *Latiala nodosa* (Packard), hypotypes, **44,** LACMIP 11406 from CIT loc. 1065, ×3, protoconch and three juvenile whorls, **45,** LACMIP 11403 from CIT loc. 1164, ×1.5, back view, **46,** LACMIP 11408 from CIT loc. 1532, ×1, apertural view, **47, 50, 52,** LACMIP 10808 (=UCLA 58438) from CIT loc. 1212, ×1, **47,** wing angle, **50,** apertural view, photo by T. Susuki, **52,** back view, photo by T. Susuki, **48,** LACMIP 11407 from CIT loc. 1212, ×2, juvenile to mature sculpture, **49,** LACMIP 11405 from CIT loc. 1164, ×1.5, apertural view, **51,** LACMIP 11404 from CIT loc. 1164, ×1.5, back view.

Table 7. Measurements in mm of specimens of *Latiala sigma* n. sp.

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
LACMIP 11392	35.2†	6.5	13.0	10.9	1.7	13.4	40°	—	—	—	16.8	13.5	18.7	3
LACMIP 11393	34.4	6.0	14.0	?	—	19.4	?	?	—	—	17.4	14.0	16.0	8
LACMIP 11391	32.4	5.0	12.0	8.8	1.8	13.5	42°	7	—	—	12.0	10.8	15.5	5
LACMIP 11394	14.6	3.8	—	5.6	1.5	—	31°	—	38•	—	—	—	—	4
LACMIP 11395	14.8	3.2	—	5.4	1.7	—	35°	—	60•	—	—	—	—	7
LACMIP 11396	9.5	2.0	—	3.7	1.8	—	34°	—	60•	—	—	—	—	6
LACMIP 11397	8.5	1.7	—	3.0	1.8	—	35°	—	58	—	—	—	—	6
LACMIP 11398	8.7	1.8	—	3.6	2.0	—	34°	—	58	—	—	—	—	5
LACMIP 11399	18.4	3.9	9.3	6.6	1.7	9.6	35°	4?	—	—	—	—	—	4
LACMIP 11400	38.0	7.0	16.9	12.2	1.7	19.0	35°	6+	—	—	13.9	13.9	—	6
LACMIP 11401	29.8	5.0	13.8	10.7	2.1	14.6	37°	6	—	—	—	—	—	5
LACMIP 11402	29.0	4.5	10.7	7.9	1.8	13.8	32°	—	38•	—	—	—	—	6

A = pleural angle; D = diameter last whorl; Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; • = axial ribs counted on one side of whorl and doubled.

Geographic distribution: Redding Formation, Melton Sandstone, Redding area, Shasta County, California. [CIT loc. 1264; CIT loc. 1265; CIT loc. 1266; CIT loc. 1346 = UCLA loc. 5421]

Remarks: *Latiala sigma* has the strongest spiral sculpture and longest rostrum of the *Latiala* discussed herein. All of the available mature specimens have the shell badly leached and the adult whorl surface is not preserved on any of them. Winged adults range in size from about 22 mm high to 46 mm high. None of the available specimens shows evidence of thickening along the distal margin of the wing. Obscure swellings that may be indistinct varices are present on some early whorls. *Latiala sigma* has a more gradate spire, more axial ribs on the immature whorls, and the distal edge of the wing is at a greater angle to the shell axis than in *L. nodosa*. It is larger, has a broader wing, and has more axial ribs on its body whorl than *L. californica* and *L. heliaca*.

Etymology: *Sigma*, the eighteenth letter of the Greek alphabet, was W. P. Popenoe's manuscript name for this species.

Latiala nodosa (Packard, 1922)
Figures 44–52; Table 8.

Alaria nodosa Packard, 1922, p. 430, pl. 36, figs. 5a-5b.
Arrhoges californicus (Gabb)—Jones, Sliter and Popenoe, 1978, p. xxii.9, pl. 1, fig. 10.
Arrhoges (Latiala) californicus (Gabb)—Popenoe, 1983, p. 76 (in part), fig. 6 F, I.

Diagnosis: A thick-shelled *Latiala* with about four teleoconch whorls having 14 oblique axial ribs per whorl, seven to eight axial ribs on body whorl not restricted to back of whorl, and a broad wing.

Description: Shell thick for a *Latiala*, of medium size, spindle-shaped, except for expanded mature labrum; whorls twice as wide as high, numbering about nine; last whorl a little over half of shell height; pleural angle about 37°; whorl profile on spire rounded but ribs create incipient shoulder; profile of last whorl rounded but with apparent angulation caused by nodes; commonly one varix per submature whorl; outer lip expanded, moderately broad, subquadrate with short anterior and posterior projections; angle of distal edge of outer lip to that of shell axis about 22°. Protoconch of four smooth rounded whorls. Sculpture on fifth and sixth whorl of about 20 low, oblique, gently concave to aperture, crested axial ribs, on penultimate whorl of 14 axial ribs; body whorl sculptured by seven to eight axial ribs forming nodose shoulder; all postprotoconch whorls with fine spiral striae, strongest near the posterior suture. Aperture elongate, outer lip thickened and not channeled; callus deposit over apertural face of body whorl extending as broad tongue over penultimate whorl to posterior suture; inner lip thin edged, medially thickened; rostrum short.

Type specimens: Holotype UCBMP 12297. Paratype

Table 8. Measurements in mm of specimens of *Latiala nodosa* (Packard).

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
UCLA 58438	31.5	5.5	16.9	12.0	2.2	12.0	32°	9	—	15	15.6	14.8	17.0	3
LACMIP 11403	24.7†	5.5	11.5†	9.0	1.6	14.0†	30°	—	?	14	11.8	11.2	12.0†	5
LACMIP 11404	29.8†	5.8	13.0	9.8	1.7	12.6†	38°	4	—	17	11.4†	—	—	4
LACMIP 11405	26.4†	4.4	11.0	8.2	1.9	13.8	36°	7	?	14•	9.8	10.0	11.3†	7
LACMIP 11406	9.9	1.9	5.5	4.0	2.1	—	34°	—	20•	—	—	—	—	6
LACMIP 11407	23.0	3.8	—	9.0	2.4	—	42°	—	20	14	—	—	—	7
LACMIP 11408	31.8	4.9	14.3	11.4	2.32	13.5	40°	6	—	16•	13	16	17.7	4
LACMIP 11409	35.5	5.8	16.0	12.0	2.06	16.4	40°	11	—	16•	—	—	—	5

A = pleural angle; D = diameter last whorl; Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; † = broken, crushed; • = axial ribs counted on one side of whorl and doubled.

UCBMP 12296 from UCBMP loc. 2142, Santa Ana Mts., Orange County, California

Hypotypes: UCLA 58438 (=LACMIP 10808) (*A.* (*L.*) *californicus* of Popenoe) from CIT loc.1212 (=LACMIP loc.10735), LACMIP 11407 from CIT loc. 1221, and LACMIP 11408–11409 from CIT loc. 1532, Redding area, Shasta County; LACMIP 11403–11405 from CIT loc. 1164, Santa Ana Mountains, Orange County, California.

Type locality: UCBMP loc. 2155, 5.43 km S 65°E of B.M. 610, Corona sheet. 0.8 km from mouth of Black Star Cañon. Chico float.

Dimensions: See Table 8.

Age: Turonian.

Geographic distribution: Ladd Formation, Baker Canyon Sandstone and lower Holz Shale Members, Santa Ana Mountains, Orange County, California, (CIT loc. 80, 1 spec.; CIT loc. 82, 12 spec.; CIT loc. 99, 2 spec.; CIT loc. 454, 1 spec.; CIT loc. 1065, 4 immature spec.; CIT loc. 1164, 59 spec.; CIT loc. 1290, 1 spec.; CIT loc. 1307, 8 spec.; UCLA loc. 2325, 2 spec.; LACMIP loc. 10953, 1 spec.; LACMIP loc. 29181, 1 spec.); Redding Formation, Frazier Silt, Redding area, Shasta County, California, (CIT loc. 1212, 16 spec.); CIT loc. 1221, 3 spec.; CIT loc. 1532, 14 spec.; UCLA loc. 4658, 15 spec.).

Remarks: Precise stratigraphic position of the holotype was unknown to Packard (1922), but the paratypes are from UCBMP loc. 2142, which is in the lower Holz Shale. The species has been collected from numerous localities in the Baker Canyon Sandstone and lower Holz Shale Members of the Ladd Formation.

Popenoe (1983) included *L. nodosa* in *A.* (*L.*) *californicus*, but the early whorls of *L. nodosa* have fewer axial ribs per whorl, the earliest of which are so low that the spiral riblets adjacent to the posterior sculpture is the more noticeable sculptural element. The early axial ribs of *L. nodosa*, are characteristically distant and crested with the sharp slope toward the aperture. *Latiala nodosa* has axial ribs on the apertural face of the body whorl but *L. californica* does not, and *L. californica* has a better-defined shoulder and fewer varices on the early whorls. Although *L. nodosa* is common to abundant at more than four localities, few specimens have the earliest whorls well-preserved. LACMIP 11406 and other specimens from CIT loc. 1065 have well-preserved early sculpture; LACMIP 11407 appears to have nearly all of the early whorls, but the shell surface of the first four whorls is not preserved. Remnants of fine axial ribs are present on the fifth whorl and 14 ribs are on the sixth whorl. The fifth whorl has two ribs for each rib on the sixth whorl. Callus on the apertural face of the body whorl is thick enough to obscure some of the axial ribs and forms a broad lump at the base of the body whorl adjacent to the aperture. It extends apically from the posterior end of the aperture forming a callus tongue

across the penultimate whorl. A thin and fairly narrow inner lip is developed over the callus.

Redding area specimens of *L. nodosa* are larger, more robust, and have a wider pleural angle than those from the Santa Ana Mountains. In the Redding area, *L. nodosa* and *L. sigma* are of similar size, but *L. nodosa* has a thicker shell, a more quadrate wing, the distal edge of which is at a lower angle to the shell axis, and early whorls with fewer axial ribs and weaker spiral striae. *Latiala nodosa* is from the Frazier Silt but *L. sigma* is from the Melton Sandstone. Of the five species of *Latiala* described in this paper, *L. nodosa* has the tallest wing relative to breadth and to shell height.

Genus *Alarimella* new genus

Type species: *Aporrhais vetus* Packard, 1922 from the Turonian of southern California.

Diagnosis: A *Rimella*-like aporrhaid with sculpture of nearly aligned axial ribs and finer spiral cords but with an expanded outer lip. Whorls becoming carinate on body whorl; carina extending along trigonally expanded outer lip; outer lip with a posterior digitation proximal or adnate to the spire; interior of outer lip channeled opposite the carina.

Discussion: *Alarimella* is very similar in shape and sculpture to some strombids such as the *Rimella*-like gastropods (Clark and Palmer, 1923) of the Rostellarinae (Delpey, 1941). Certain species of *Calyptraphorus* Conrad, 1857, e. g., *Calyptraphorus binodiferus* Perrilliat and Vega, 1997, Maastrichtian, southern Mexico, also have similar shape and sculpture beneath their mature callus covering. The shape of the aperture and extension of the posterior canal up the spire of *Alarimella* also are similar in these strombids. The most obvious difference is in the outer lip of *Alarimella* which is alately expanded and interiorly channeled but in the *Rimella*-like strombids is not. Additionally the aperture of aporrhaids has sinus areas on either side of the rostrum and a concave columella which accomodate the anterior end of the foot and the snout, but the strombid shell is less excavated across the anterior end of the columella. Strombs characteristically have a strombid notch near the anterior end of the outer lip which is used by the stalked eye of strombs (Abbott, 1960). The eyes of aporrhaids are on bulbs at the tentacle bases (Yonge, 1937) rather than on long, mobile pedicle tips and are not extendible as in the strombs. Possibly stalked eyes evolved in advance of the notch through which they extend, and absence of the strombid notch does not assure aporrhaid eyes. The strombid notch is not always well defined in strombs (Savazzi, 1991), and some of the *Rimella*-like gastropods are said not to have a strombid notch, e. g. *Rimella* Agassiz, 1840, *Macilentos* Clark and Palmer, 1923 (subobsolete fide Clark and Palmer, 1923, lacking fide Vokes, 1939), *Coulitzia* Clark and Palmer, 1923. Nonetheless, the absence of a strombid notch in *Alarimella* in conjunction with the similarity of the sculpture of *Alarimella* on the whorls of the spire to that of *Latiala*, *Perissoptera*, and *Graciliala*, the development on the body whorl of *Alarimella* of a modest carina, and the possession by *Alarimella* of an expanded outer lip that is internally channeled opposite the carina suggest that it be included in Aporrhaiidae.

Varices on spires of *Alarimella veta* and *A. anae* are similar to those on species of *Rimella*. Varices are said to be of little or no systematic importance in Strombaceans (e. g. Davies, 1971, p. 328), and their presence does not aid in differentiating between Aporrhaidae and Strombidae, but Clark and Palmer (1923) thought their absence on *Macilentos* characteristic.

As in several aporrhaids (e. g., *Latiala*) the sculpture on the body whorl of *Alarimella* not only differs from that on the spire, but the back of the body whorl has fewer and stronger ribs than the previous whorl, and on the apertural face, ribs may be virtually absent. A similar pattern of enlarged nodes on the back of the body whorl appears to be present in *Calyptraphorus binodiferus* and in some of the *Rimella*-form gastropods (*e.g., Rimella*). Savazzi (1991) suggests that such enlarged nodes assist an animal that has landed aperture up to right itself.

Length and deployment of the posterior canal is considered a supraspecific characteristic among the *Rimella*-like gastropods (Clark and Palmer, 1923). None of the specimens of *A. veta* has a complete spire, but the posterior canal appears to end on the juvenile whorls, and the canal of a specimen of *A. anae*, which has probably not reached its full length, does not extend to the tip of the spire nor does it change direction and extend across the back of the spire as in *Calyptraphorus binodiferus*. *Alarimella* is sufficiently similar to *Rimella*-like gastropods, except for the expanded outer lip, to suggest that *Rimella*, may be derived from *Alarimella* by the reduction of the outer lip and lengthening of the posterior canal. Similarity of sculpture of *Calyptraphorus binodiferus* to that of *A. veta* suggests that *Calyptraphorus* Conrad, 1857, might also derive from an *Alarimella*-like form by reduction of the outer lip, lengthening of the posterior canal, and increase of callus deposition over the shell. Roy (1996) indicated that strombids originated within the aporrhaids during Cenomanian-Turonian times, which places *Alarimella* near the time of divergence.

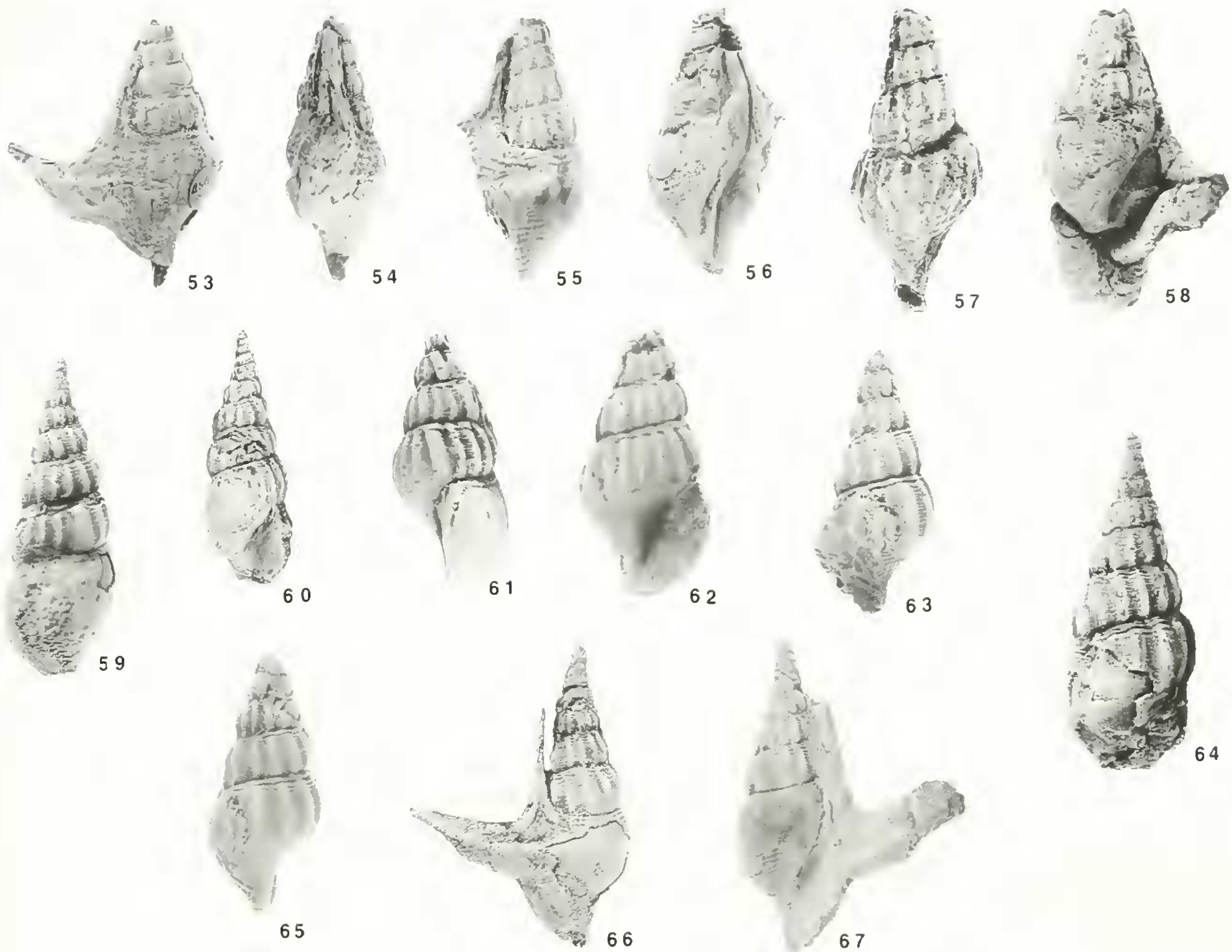
Figures in Korobkov et al. (1960, p. 188) of *Pugioptera subrequieni* Pchelintsev, 1953 from the Turonian of Transcaucasia are suggestive of *Alarimella*, but *Rostellaria requieniana* d'Orbigny, 1842, the type species of *Pugioptera* Pchelintsev, 1953, is an *Anchura* Conrad, 1860 (Korobkov et al., 1960, p. 183 have *Rostellaria requenana* as type species, a misspelling of *R. requieniana* spelled correctly on page 187 in the explanation for Figure 453).

Etymology: *Ala* wing, Latin and *Rimella* a gastropod.

Alarimella veta (Packard, 1922)
Figures 53–58; Table 9.

Aporrhais vetus Packard, 1922, p. 431, pl. 36, fig. 1

Diagnosis: An *Alarimella* with the outer lip expanded into a broad triangle.



Figures 53–67. All whitened with ammonium chloride. **53–58.** *Alarimella veta* (Packard), hypotypes, **53–54,** USNM 494820 from USGS loc. 2759, ×1, **53,** back view, **54,** labral side showing wing angle, **55–56,** LACMIP 11415 from CIT loc. 978, ×1, **55,** back view, **56,** apertural view, **57,** LACMIP 11416 from CIT loc. 1067, ×1.5, ablabral side, **58,** USNM 494821 from USGS loc. 2759, ×1, apertural view showing channel in wing. **59–67.** *Alarimella anae* n. sp. from CIT loc. 1065, **59–60,** paratype LACMIP 11412, **59,** ×2, back view, **60,** ×1.5, apertural view, **61–62,** paratype LACMIP 11411, ×2, **61,** labral side, **62,** apertural view, **63, 65,** paratype LACMIP 11413, ×3, **63,** back view, **65,** ablabral side, **64,** paratype LACMIP 11414, ×2, apertural view, **66–67,** holotype LACMIP 11410, ×2, **66,** apertural view, **67,** back view.

Description: Shell medium sized, high spired with pleural angle of about 26°; whorl profile on spire flatly convex becoming angulate on ultimate whorl; suture appressed, shallow; body whorl relatively enlarged with a short, straight rostrum; body whorl carina extending onto expanded, triangulate outer lip of nearly equal height and breadth and having a short posterior digitation at its distal margin; posterior edge of outer lip extended upward along spire to form outer, thicked edge of posterior canal; inner lip thickened and extended to form inner edge of canal along spire; interior of outer lip channeled opposite the carina. Sculpture of spire dominated by straight axial ribs, about 16 per whorl, nearly alligned from whorl to whorl, narrower than the interspaces, axial ribs evanescing on apertural side of ultimate whorl but present on back; spiral sculpture of fine cords on spire and about four posterior to carina on ultimate whorl, nearly effaced on mid whorl, becoming stronger anteriorly, about six on base.

Type specimens: Holotype UCBMP 12298.

Hypotypes: LACMIP 11415 from CIT loc. 978 and 11416 from CIT 1067; USNM 494820–494821 from USGS loc. 2759, all in the Santa Ana Mountains, Orange County, California.

Type locality: UCBMP loc. 2171, "4 miles [6.44 km] SW of Corona, Corona Sheet. At clay mine, 200 feet [61 m] up the cañon from a cabin" (Packard, 1922), Riverside County, California.

Dimensions: See Table 9.

Geologic age: Turonian.

Geographic distribution: Upper Baker Canyon

Table 9. Measurements in mm of specimens of *Alarimella veta* (Packard).

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
UCBMP 12298	28.3	5.0	13.0	9.8	2.0	14.0	29°	—	—	—	10.7	9.5	9.4	4
USGS 2759-1	36.5†	5.6	29.4	10.9	1.9	16.8†	28°	14	—	16•	16.5	9.8	14.8	5
USGS 2759-2	37.0†	6.4	25.7†	12.4	1.9	16.8†	25°	—	—	16•	12.0†	8.5	—	4
LACMIP 11415	37.0†	6.5	24.4	10.7	1.6	19.4†	23°	—	—	18•	—	—	—	5
LACMIP 11416	28.9†	5.0	15.0†	8.5†	1.7	12.7	—	14	—	14	8.7†	—	—	4

A = pleural angle; D = diameter last whorl, Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; † = broken, crushed; • = axial ribs counted on one side of whorl and doubled.

Member and lower Holz Shale Member of the Ladd Formation in the Santa Ana Mountains, Orange and Riverside Cos., California (UCBMP loc. 2142, 3 spec.; UCBMP loc. 2171, 1 spec.; USGS loc. 2729, 2 spec.; CIT loc. 1065, 2 spec.; LACMIP loc. 15295, 2 spec.; CIT loc. 979, 2 spec.; LACMIP loc. 10898, 2 spec.; CIT loc. 978, 4 spec.; CIT loc. 1067, 1 spec.

Remarks: Packard (1922) only mentioned the one rather poorly preserved specimen from UCBMP loc. 2171 on the east side of the Santa Ana Mountains, Riverside County, California. He was unsure of the stratigraphic position of this outcrop. Packard (1916) included a sketch map but did not include positions of fossil localities on it. Grey's (1961) map covering the area roughly "4 miles [6.44 km] SW of Corona" indicates that part of the rocks considered Cretaceous by Packard are now mapped as Silverado Formation of Paleocene age. Although many of the clay mines of that area are in strata of Paleocene age, and *Alarimella veta* resembles *Macilentos macilentus* (White, 1889), an early to middle Eocene species (Squires, 1987), no undoubted Paleocene specimens with an expanded outer lip have been found. Furthermore Grey (1961, p. 22) lists *Aporrhais* cf. *A. vetus* from his locality 11 in the Baker Canyon Sandstone Member on the north side of Tin Mine Canyon, sec. 10, T4S, R7W, Corona South quadrangle (Grey, 1961, pl. 1), a locality that is near the southern end of the outcrops of Cretaceous age that are roughly 6.44 km SW of Corona. Specimens of *A. veta* are uncommon but have been collected from several localities in the upper Baker Canyon Member and lower Holz Shale Member of the Ladd Formation in the vicinity of Silverado Canyon, Orange County, California. UCBMP loc. 2142, a locality included in Packard's study, contains several specimens of *A. veta*.

Specimens of *A. veta* lacking the adult apertural characteristics of having a posterior canal up the spire resemble *Latiala nodosa* (Packard, 1922), but they have stronger spiral scuplture than does *L. nodosa*, which also differs from the former in having a slightly more angulate whorl profile with somewhat nodose axial ribs. The wing of *L. nodosa* is taller and has a longer, straighter distal margin with a pronounced anterior projection.

Alarimella veta resembles illustrations of *Calyptraphorus binodiferus* of Maastrichtian age from Guerrero, southern Mexico, in scuplture and shape, but *A. veta* lacks the callus covering of *C. binodiferus*, and *C. binodiferus* lacks the wing of *A. veta*. *Alarimella veta* has stronger sculpture, a shorter posterior canal, and a narrower pleural angle than *C. binodiferus*.

LACMIP 11415 was encrusted on the back of the outer lip and up the spire by calcareous "worm" tubes, and oysters. Tubes are also on the apertural base of the columella, and the shell was bored by sponges. The penultimate whorl has a predepositional hole and the anterior portion of the outer lip has a curved broken edge, both of which suggest that the specimen may have been attacked by a crab.

Table 10. Measurements in mm of specimens of *Alarimella anae* n. sp.

	H	Hp	D	Dp	Dp/Hp	S	A	R	Rj	Rp	WB	WH	WD	Whorls
LACMIP 11410	21.0	3.8	7.7	6.5	1.7	12.4	31°	0?	14	16	8.9	3.9	—	10
LACMIP 11411	17.3†	3.9	9.0	6.8	1.7	8.6†	29°	—	—	16	—	—	—	4
LACMIP 11412	21.8	4.0	7.8	7.4	1.8	—	28°	—	14	16	—	—	—	9
LACMIP 11413	12.0	2.4	5.8	4.0	1.7	—	33°	—	14•	14	—	—	—	5
LACMIP 11414	15.6	2.8	6.4	5.5	2.0	—	33°	—	14•	18•	—	—	—	10

A = pleural angle; D = diameter last whorl; Dp = diameter of penultimate whorl; H = height; Hp = height penultimate whorl; R = axial ribs on body whorl; Rj = axial ribs on juvenile whorl; Rp = axial ribs on penultimate or other late teleoconch whorl; S = height of spire; WB = wing breadth measured from last rib to distal edge; WD = length distal margin of wing; WH = wing height except posterior and anterior spurs; † = broken, crushed; • = axial ribs counted on one side of whorl and doubled.

Alarimella anae n. sp.
Figures 59–67; Table 10.

Diagnosis: An *Alarimella* having a slender posterior spike on the outer lip proximal to the spire, a laterally directed, broad and relatively short wing, and rather coarse axial ribs on the spire.

Description: Shell small, high spired with pleural angle of about 31°; whorl profile on spire slightly convex becoming almost subangulate on ultimate whorl; strong randomly distributed varices present on spire; suture impressed; rostrum apparently short and straight; outer lip expanded into two parts: a posterior short thin spike adjacent at its base to the spire and a larger, carinate, short but broad wing extending laterally; sinus in outer lip margin adjacent to the rostrum; inner lip thin. Sculpture of spire dominated by rounded arcuate axial ribs extending from suture to base, about 16 on penultimate whorl, axial ribs disappearing on back of ultimate whorl and replaced by fine sigmoid axial lines near outer lip that extend onto rostral neck; entire shell surface covered by fine, spaced spiral cordlets.

Type specimens: Holotype, LACMIP 11410; paratypes LACMIP 11411 to 11414 all from CIT loc. 1065.

Type locality: CIT loc. 1065, about 0.97 km north of confluence of Ladd and Silverado Canyons, Black Star Canyon quadrangle, Santa Ana Mts., Orange County, California.

Dimensions: See Table 10.

Age: Late Turonian.

Geographic distribution: Known only from the type locality west of Ladd Canyon, Santa Ana Mountains, Orange County, California, in the Baker Canyon Sandstone Member of the Ladd Formation.

Remarks: *Alarimella anae* may represent early whorls of *A. veta*. The posterior spike adjacent to the spire may be an immature stage of a posterior canal along the spire. The largest specimen of *A. anae* has produced an expanded outer lip and is about half the size of the most complete specimens of *A. veta*. Only one of the nine specimens from CIT loc. 1065 has the wing preserved, and it is thin and fragile. The lip may not be fully mature but its presence suggests that the animal would not be enlarging its shell significantly. Sohl (1960) considers relative size a poor characteristic for specific differentiation among aporrhaids, and both *A. anae* and *A. veta* have about 16 axial ribs per whorl. The ribs of *A. anae* are somewhat more curved and the spiral cordlets are slightly stronger than those of *A. veta*. The fully mature shape of the wing of *A. anae* may differ from that described here. The wing has a slightly curved carina that is nearer to the posterior margin than to the anterior; the anterior side of the wing being about twice as tall as the posterior. Growth lines on the wing clearly conform to the present blade-like shape and suggest that this species had a short but broad, pointed wing.

Alarimella anae resembles illustrations of *Graciliala decemlirata* (Conrad, 1858) of Maastrichtian age from the Ripley and Owl Creek Formations of the Gulf Coast (Sohl, 1960, pl. 11, fig. 5, 11). Young specimens of *A. anae* before the growth of the wing could easily be mistaken for immature *G. decemlirata*, which according to Sohl (1960) is not typical of *Graciliala* in that the anterior border of the outer lip is not digitate. Sohl had no specimens of this species with the wing preserved and could not find Conrad's holotype, but Conrad's illustration (1858, pl. 35, fig. 11) shows a wing slightly taller but similar to that of *A. anae* and, as in *A. anae*, the anterior edge of the outer lip lacked the digitations typical of *Graciliala calcaris* (Wade, 1926) and other species of *Graciliala*.

Alarimella anae differs from *Anchura (H.) tricosa* Saul and Popenoe, 1993, which has a somewhat similar posterior spike, in having fine spiral striae rather than about 5 spiral cords on the spire whorls, fewer axial ribs, and a less angulate whorl profile. The wing of *Alarimella anae* is much shorter, less curved, and is without secondary spurs on the shank. On the ultimate whorl of *A. anae*, the axial sculpture is nearly effaced, and an axial bulge is present on the abapertural side of the apertural face.

Etymology: The specific epithet, *anae*, refers to the name of the Santa Ana Mountains, California.

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CIT and UCLA localities have been given LACMIP numbers. The CIT and UCLA numbers for Redding area and Santa Ana Mountains localities are included here because they have been plotted on published maps. Most of the CIT and UCLA localities of Turonian age in the Redding area were plotted on Jones et al. (1978: fig. 5). Most of the CIT localities of the northern Santa Ana Mountains were plotted on Popenoe (1942: fig. 2); these and UCLA localities were plotted on Saul and Bottjer (1982: maps 1–3).

80 CIT = LACMIP 8194: In sandstone above cgl., at fork of Silverado and Ladd Canyons on N side of Silverado Canyon, [NW 1/4, SW 1/4 sec.8, T5S, R7W, El Toro quad.], Santa Ana Mts., Orange County, California. Coll: B. N. Moore, 1926. Ladd Formation, Baker Canyon Sandstone. Turonian.

82 CIT = LACMIP 8195: Limey sandstone bed near base of shale, S of roadcut at Holz's Ranch (locality may become obscured by slides), Silverado Canyon [E edge SE 1/4, SE 1/4, sec.7, T5S, R7W, El Toro quad.], Santa Ana Mts., Orange County, California. Coll: B. N. Moore, 1927. Ladd Formation, Holz-Baker transition. Turonian.

99 CIT = LACMIP 8180: Concretions in shale just above sandstone on south side of Silverado Canyon coming in from south about 1 1/2 miles E of Ladd Canyon [approx. 0.12 km N, 0.07 km E of SW cor. sec.9, T5S, R7W, Santiago Peak quad.], Santa Ana Mtns., Orange County, California. Coll: B. N. Moore, 1928. Ladd Formation, Holz-Baker transition. Turonian.

454 CIT = LACMIP 10873: Cretaceous shale, fireline about Hough's 80 on S side of stream, about 400' above creek, Silverado Canyon [about 450'S, 875'E of NW cor. sec.16, T5S, R7W, Santiago Peak quad.], Santa Ana Mts., Orange County, California. Coll: B. N. Moore, 1929. Ladd Formation, lower Holz Shale. Late Turonian.

978 CIT = LACMIP 10884: NE slope, and near crest of bluff overlooking Santiago Canyon [at about NE cor. sec.33, T5S, R7W], approx. 1 1/2 mi. SE of the dam just above the mouth of Harding Canyon, Santiago Peak quad., Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe, 4/14/1933. Ladd Formation, Baker Canyon Sandstone about 100' above gray basal cgl. Turonian.

979 CIT = LACMIP 10885: 10' below 978, NE slope, and near crest of bluff overlooking Santiago Canyon [at about NE cor. sec.33, T5S, R7W, Santiago Peak quad.], Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe, 4/14/1933. Ladd Formation, Baker Canyon Sandstone, about 90' above gray basal cgl. Turonian.

1058 CIT = LACMIP 10890: North side of Silverado Canyon Road, about 15' above rd., and 300'N 72°E of Holz Ranch house, Silverado Canyon [1390'N, 210'E of SW cor. sec.8, T5S, R7W, El Toro quad.], Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe and others, 4/1/1933. Basal Baker Canyon Sandstone about 10' above top of conglomerate, Ladd Formation. Turonian.

1064 CIT = LACMIP 10893: Area S of Harding Canyon, Vulture Crags, just N of first large canyon cutting across Cretaceous beds S of Harding Canyon, about 2 mi. S42°E of the dam in Harding Canyon and 6800' N55°E of juncture of Santiago Creek and Trabuco Canyon Rds. [2600'N, 1625'E of SW cor. sec.34, T5S, R7W, Santiago Peak quad.], Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe, 10/14/1934. Lower Holz Shale, Ladd Formation. Turonian.

1065 CIT = LACMIP 10891: Ss overlying basal Upper Cretaceous cgl., from crest of scarp on W side of Ladd Canyon, about 0.6 mi. N of juncture of Ladd and Silverado Canyons [1300'S, 300'E of NW cor. sec.8, T5S, R7W, Black Star Canyon quad.], Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe, 3/3/1933. Ladd Formation, Baker Canyon Sandstone. Turonian

1067 CIT: = LACMIP 10883: Immediately above base of gray ss overlying gray basal cgl. [1800'N, 600'E of SW cor. sec.21, T5S, R7W, Santiago Peak quad.], Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe, April 21, 1932. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

1164 CIT = LACMIP 10079: S side Silverado Canyon near mouth of small N-flowing gully, and at top of lower fossiliferous sandstone series, about at top of lower fossiliferous sandstone series, about 400 feet (120 m) SE of Holz Ranch house in SE cor. sec.7, T5S, R7W [1025'N, 150'E of SW cor. sec.8, T5S, R7W, El Toro quad.], Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe, May 15, 1935. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

1212 CIT = LACMIP 10735: Little Cow Creek, ap-

prox. 2 mile (3.2 km) NE of Frazier's Corners, hard sandy concretions in shale, banks of gullies in pasture [about 2500'N, 750'W of SE cor. sec. 4, T32N, R3W, Millville quad.], Shasta County, California. Coll: W. P. Popenoe, 1933. Redding Formation, Frazier Silt. Turonian.

1221 CIT = LACMIP 10738: about 1/4 mi. N of Alturas-Redding hwy U.S. 299 and 1.6 mi. by rd NE of Frazier's Corners, S facing shale bank along Jim Creek [250'S, 700'W of NE cor. sec.8, T32N, R3W, Millville quad.], Shasta County, California. Coll: Popenoe and Ahlroth, June 29, 1936. Redding Formation, upper Frazier Silt Member. Turonian.

1264 CIT = LACMIP 10750: Massive, brown sandstone cropping out in bed of small gully tributary to Little Cow Creek [approx. 1850'S, 2250'E of NW cor. sec.9, T32N, R3W, Millville quad.], Shasta County, California. Coll: W. P. Popenoe, April 12, 1937. Redding Formation, basal Melton Sandstone Member. Turonian

1265 CIT = LACMIP 10751: Right bank of Little Cow Creek, about 50' from creek [0.58 km S, 0.48 km W of NE cor. sec.9, T32N, R3W, Millville quad.], Shasta County, California. Coll: W. P. Popenoe, 4/15/37. Redding Formation, Melton Sandstone Member. Turonian.

1266 CIT = LACMIP 10752: Right bank of Little Cow Creek about 500 ft. downstream from CIT 1265 [center of sec.9, T32N, R3W, Millville quad.,] Shasta County, California. Coll: W. P. Popenoe, April 15, 1937. Redding Formation, Melton Sandstone Member. Late Turonian.

1290 CIT = LACMIP 10135: S side of prominent hill W of Mustang Spring, about 1500' nearly due N of Holz Ranch house, north side Santiago Canyon, sec.7, T5S, R7W, [Black Star Canyon quad.], Santa Ana Mountains, Orange County, California. Coll: Popenoe, Wells, Church, Henshaw, and Fiedler, April 6, 1937. Ladd Formation, near top Baker Canyon Sandstone Member. Late Turonian.

1307 CIT = LACMIP 8169: About 25' E of CIT 1290 and not more than 10' stratigraphically below CIT 1290, W of Mustang Spring, north side Santiago Canyon, sec.7, T5S, R7W, [Black Star Canyon quad.], Santa Ana Mountains, Orange County, California. Coll: W. P. Popenoe, April 24, 1937. Ladd Formation, Baker Canyon Sandstone Member. Late Turonian.

1346 CIT = UCLA 5421; LACMIP 10754: Sandstone nodules in shale, left bank of Little Cow Creek, about 70 m NE (upstream) from intersection of creek bed with S line of sec. 9 [1500'N, 2200'E of SE cor. sec.9, T32N, R3W, Millville quad.], 10 mi. NE of Redding, Shasta County, California. Coll: W. P. Popenoe and Jane Hoel, 7/8/1937. Redding Formation, Melton Sandstone Member. Turonian.

1532 CIT = LACMIP 10815: Concretions in shale near right bank Salt Creek [approx. 600'N, 700'W of SE cor. sec.4, T32N, R3W, Millville quad.], Shasta County, California. Coll: Popenoe and Ahlroth, July 10, 1936. Redding Formation, near top Frazier Silt Member. Turonian

2142 UCBMP: 2 1/4 miles NNW of B.M. 1271, Corona sheet. Left side of Silverado Cañon, in shales undercut by the stream about 200 ft. southeast of the road. Ladd Formation, lower Holz Shale Member. Turonian

2171 UCBMP: 4 miles SW of Corona, Corona Sheet [Corona South quad.]. At clay mine, 200 feet up the cañon from a cabin, Riverside County, California. Ladd Formation. Turonian.

2325 UCLA = LACMIP 22325: Small gully entering Silverado Canyon from S, just W of the narrows, about 9000' upstream from the mouth of the canyon, and directly S from farmhouse on Holz Ranch, about 1025'N, 150'E of SW cor. sec.8, T5S, R7W, El Toro quad., Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe, 1946. Ladd Formation, top of Baker Canyon Member. Turonian.

2759 USGS: Near Silverado Canyon, in lower part of Ladd Canyon, Santa Ana Mountains Orange County, California. Coll: S. Bowers, April 24, 1903. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

3465 UCLA = LACMIP 23465: Fossils in small knob of sandy cgl., on North Fork of Cottonwood Creek, about 1500'SSW of UCLA 3464, 0.38 mi. N, 0.3 mi. E of SW cor. sec.16, T30N, R6W, Ono quad., Shasta County, California. Coll: P. U. Rodda and M. A. Murphy, May 1955. Budden Canyon Formation, Bald Hills Member. Late Cenomanian.

4365 UCLA = LACMIP 24365: In fine grained ss with *Romaniceras*, left bank of French Creek (north end Swede Basin), approx. 500'N and W of SE cor. sec.5, T32N, R2W, Millville quad., Shasta County, California. Coll: W. P. Popenoe, 8/25/1957. Redding Formation, basal bed of ?Frazier Siltstone, Turonian.

4658 UCLA: Concretions at top of Frazier Siltstone, right bank of Salt Creek, about 1000'N, 400'W of SE cor. sec.4, T32N, R3W, Millville quad., Shasta County, California. Coll: W. P. Popenoe, Aug. 1961. Redding Formation, Frazier Siltstone Member, Turonian.

5421 UCLA = LACMIP 25421: Sandstone nodules in shale, left bank of Little Cow Creek, about 5' above the channel bottom, about 70 m NE (upstream) from intersection of creek bed with line fence, and about 1/4 mi. downstream from old Walter Melton farmhouse [S line sec.9, T32N, R3W, Millville quad.], Shasta County, California. Coll: W. P. Popenoe, summer, 1937.

Redding Formation, Melton Sandstone. Turonian.

10876 LACMIP = CIT 1042: Limey lenses in ss cropping out on N bank of Rancheria Gulch, about 1.5 mi. W of Henley [approx. 210'S, 800'E of NW cor. sec.30, T46N, R6W, Hornbrook quad.], Siskiyou County, California. Coll: Popenoe and Findlay, Sept. 8, 1933. Hornbrook Fm., Osburger Gulch Sandstone Member. Turonian.

10895 LACMIP: North side of Harding Canyon, north of Modjeska Reservoir, at elev. 1705', 1775'N, 1075'E of SW cor. sec.21, T5S, R7W, Santiago Peak quad., Santa Ana Mts., Orange County, California. Coll: L. J Czel, spring 1958. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

10898 LACMIP: North side of Harding Canyon, north of Modjeska Reservoir, at elev. 1750', 950'N, 600'E of SW cor. sec.21, T5S, R7W, Santiago Peak quad., Santa Ana Mts., Orange County, California. Coll: L. J. Czel, spring 1958. Baker Canyon Sandstone, Ladd Formation. Turonian.

10901 LACMIP = CIT 1044: Right bank of Rancheria Gulch just over hill north from Scholz Ranch house, 1.5 mi. W of Henley, 535'S, 1435'W of NE cor. sec.30, T47N, R6W. Yreka quad., Siskiyou County, California. Coll: W. P. Popenoe and W. A. Findlay, Sept. 1933. Hornbrook Fm., Osburger Gulch Sandstone Member. Turonian.

10953 LACMIP: Holz Ranch, north side of Silverado Canyon, on ridge top west of Ladd Canyon at approx. 1510' elev., approx. 197' above base of upper Baker Canyon Sandstone, 2550'N, 520'E of SW cor. sec.8, T5S,. R7W, Black Star Canyon quad., Santa Ana Mts., Orange County, California. Coll: R. G. Cassi, spring 1958. Ladd Formation, upper Baker Canyon Member. Turonian.

15295 LACMIP: South side of Silverado Canyon near mouth of small N-flowing gully, about 400' SE of Holz Ranch house, 1025'N, 150'E of SW cor. sec. 8, T5S, R7W, El Toro quad., Santa Ana Mts., Orange County, California. Coll: Robert Drachuk, 1979. Top of Baker Canyon Sandstone Member, Ladd Formation. Turonian.

16838 LACMIP: Float—North Fork of Cottonwood Creek, 3/4 mi. downstream from mouth of Huling Creek, Sec.21, T30N, R6W, Ono quad., Shasta County, California. Coll and date unknown. Budden Canyon formation, Bald Hills Member. Cenomanian.

24370 LACMIP (=CIT 1020; UCLA 4370): Sandstone boulder in heavy conglomerate, channel of Elder Creek, about 0.8 mi. N and E of SW cor. sec.14, T25N, R6W, at east edge of Colyear Springs quad., Tehama County, California. Coll: W. P. Popenoe and W. A. Findlay, August 18, 1933. Great Valley Series, Budden Canyon Formation. Cenomanian or late Albian boulder in Turonian sandstone.

24670 LACMIP = UCLA 4670: Sandstone cropping out in bed and on west bank of Grave Creek, W of road, 2400'N of SW cor. sec.5, T34S, R4W, Wimer 1954 15' quad., Jackson County, Oregon. Coll: W. P. Popenoe, Aug. 20. 1960. Late early–middle Albian.

25422 LACMIP = UCLA 5422: Rancheria Gulch, about 1 mi. W of Henley, and approx. 400'N, 2000'W of SE cor. sec.19, T47N, R6W. Yreka 30' quad. (1939), Siskiyou County, California. Coll: W. P. Popenoe, summer 1951. Hornbrook Formation, Osburger Gulch Member. Turonian.

28788 LACMIP: (=USGS loc. 14528) boulder in cgl., NW end of McLure Valley = Sunflower Valley, elev. 1420', 1250'N, 775'W of SE cor. sec.20, T23S, R17E, Reef Ridge quad., Kings County, California. Coll: Ralph Stewart. Panoche Formation. Cenomanian.

29181 LACMIP: Hill north of Holz Ranch house at about 1500' elev., sec. 8, T5S, R7W, Black Star Canyon quad., Santa Ana Mts., Orange County, California. Coll: W. P. Popenoe. Ladd Formation, Baker Canyon Sandstone Member. Turonian.